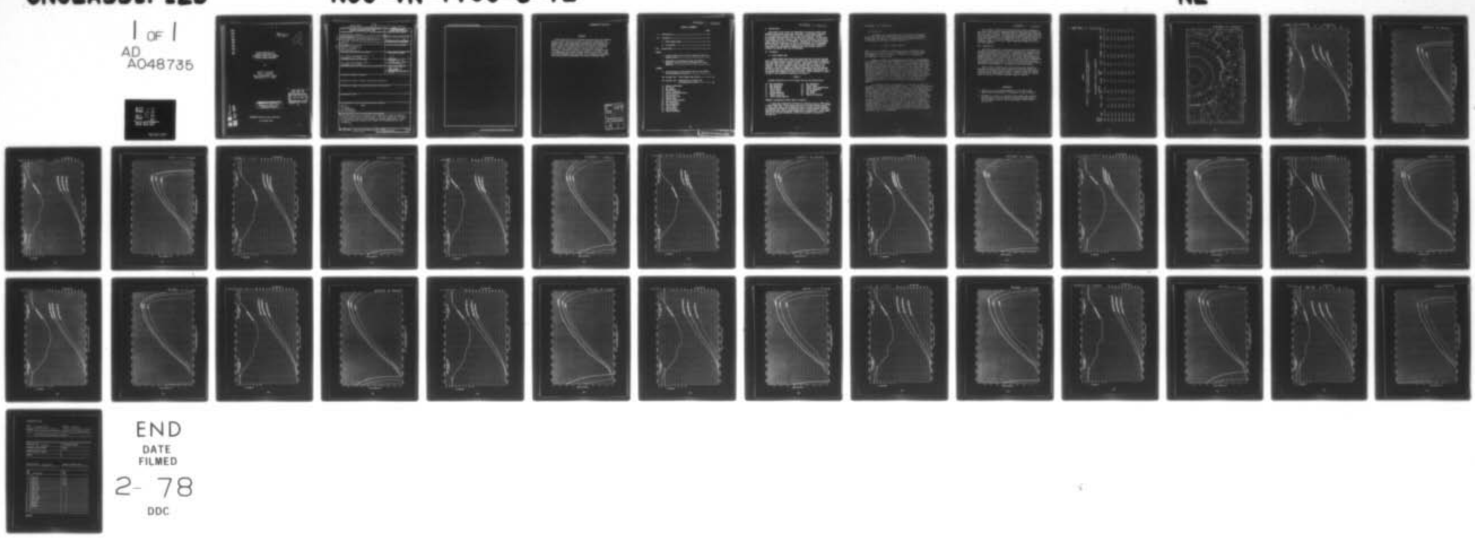
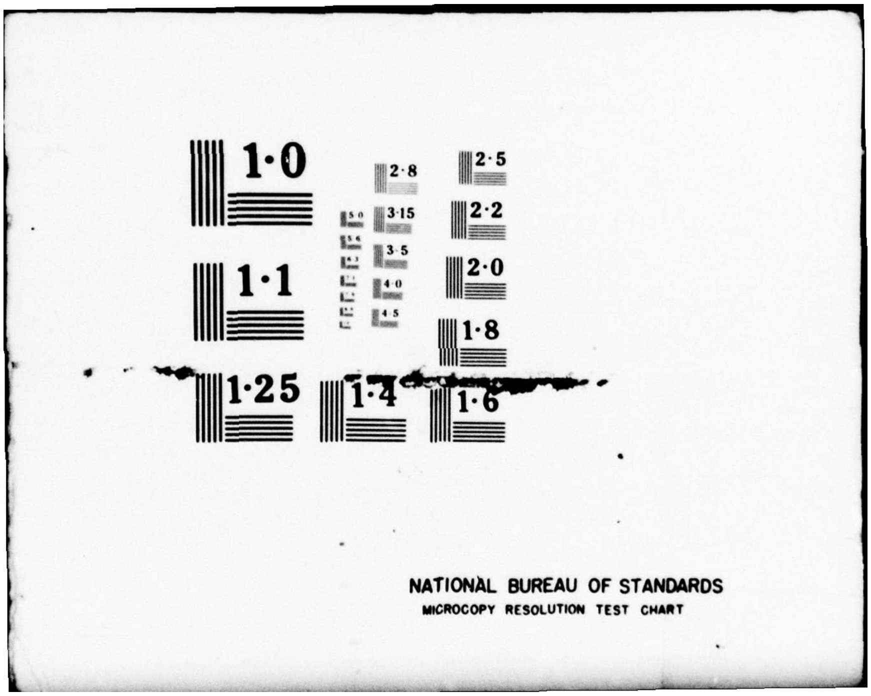
AD-A048 735 NAVAL OCEANOGRAPHIC OFFICE WASHINGTON D C F/G 8/12
FROST DEGREE DAY AND RELATED THEORETICAL ICE THICKNESS CURVES F--ETC(U)
OCT 72 G T POTOCSKY, P A MITCHELL

UNCLASSIFIED N00-TN-7700-8-72 NL

1 OF 1
AD
A048735



END
DATE
FILMED
2-78
DDC


1·0
2·8
2·5
3·15
2·2
3·5
1·1
2·0
4·0
4·5
1·8
1·25
1·4
1·6
NATIONAL BUREAU OF STANDARDS
MICROCOPY RESOLUTION TEST CHART

Code
Copy 19

FROST DEGREE DAY AND RELATED THEORETICAL ICE THICKNESS CURVES FOR SELECTED RUSSIAN ARCTIC STATIONS

by

Gabriel J. Potocsky
Peter A. Mitchell
Naval Oceanographic Office
Washington, D. C. 20390

NAVOCEANO Technical Note 7700-8-72

26 October 1972

UNCLASSIFIED (14)

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered) NOO-TN-7700-8-72

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER Technical Note 7700-8-72	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) (6) Frost Degree Day and Related Theoretical Ice Thickness Curves for Selected Russian Arctic Stations.		5. TYPE OF REPORT & PERIOD COVERED (9) Technical note
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) (10) Gabriel T./Potocsky Peter A./Mitchell		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Naval Oceanographic Office Washington, D.C. 20373		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS (11)
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Naval Oceanographic Office Washington, D.C. 20373		12. REPORT DATE 1972 26 Oct 72
		13. NUMBER OF PAGES 37
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) (12) 39p. UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Arctic
Ice Growth
Air Temperature
Sea Ice Thickness
USSR

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Frost-degree data for 15 locations on the USSR Arctic coast are used to construct theoretical ice growth curves. The frost degree data are based on mean monthly and mean daily maximum and minimum temperatures. Zubov's ice growth equations converts frost degree day accumulations into ice thickness.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE
S/N 0102-014-6601 | 250 450 UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

ABSTRACT

Frost degree data for 15 selected locations along the northern Russian Arctic coast are utilized to construct theoretical ice growth curves. The frost degree accumulations are based on mean monthly, mean daily maximum and mean daily minimum temperature data. Zubov's ice growth equation is the basis for converting frost degree day accumulations at these stations into ice thickness. The date of initial ice formation is estimated from the temperature and assumed salinity values in this area. Rate of ice disintegration and the dates of ice breakup are estimated from AVCS satellite photographs and various historical data.

TABLE OF CONTENTS

I. Introduction

Some areas of the Arctic are thoroughly surveyed by aerial reconnaissance and surface ships year after year. Accordingly, knowledge of ice conditions in these areas is well documented and reliable ice analyses and predictions can be made when required. In many areas of strategic interest, however, there are no conventional ice observations available to the ice forecaster. Through use of satellite photographs some characteristics of the ice distribution can be determined for such areas. When these analyses are correlated with accumulated frost degree day information compiled from local weather reports a reliable ice growth curve can be developed.

II. Procedure

A. Frost Degree Days

Frost degree day curves were constructed for 15 arctic and subarctic stations along the northern Russian coast utilizing air temperature data from synoptic weather reports. The station record used ranged from 1957-1969 at four stations and from 1964-1969 at eleven of the stations. The daily synoptic weather reports were used during the period of record to compute mean monthly temperatures for each station. In addition mean daily maximum and mean daily minimum temperatures for each month were computed for years of record. These stations are listed in table 1 and identified numerically in figure 1.

Table 1

Location Identifier for Frost Degree Day and Ice Growth Curves

1.*	Mys Golomyannyy	9.	Mys Shalaurova
2.	Mys Chelyuskin	10.	Bukhta Tiksi
3.	Mys Zhelaniya	11.	Ostrov Chetyrekhstolbovoy
4.	Ostrov Belyy	12.	Ostrov Vrangelya
5.	Ostroy Dikson	13.	Mys Shmidta
6.	Malyye Karmakuly	14.	Mys Uelen
7.	Ostrov Kotel'nyy	15.	Bukhta Provideniya
8.	Ostrov Predbrazheniya		

*Numbers correspond to those shown in figure 1.

A daily mean temperature 1°F below an arbitrary base of 32°F defines a frost degree day. Frost degree day curves for each station consist of a normal frost degree day accumulation and an envelope showing maximum and minimum frost degree accumulations based on mean monthly, mean daily maximum and mean daily minimum temperatures, respectively. Frost degree day curves and mean temperature curves are depicted in figures 2A through 16A.

B. Ice Growth

Ice growth and disintegration curves related to the maximum, minimum and normal frost degree day curves are depicted in figures 2B through 16B. Theoretical ice growth curves were constructed by use of a variation of the Zubov ice growth equation (1)

$$1.43\ I^2 + 28.6\ I - FDD = 0$$

where I is ice thickness in inches, and FDD is cumulative frost degree days in degrees Fahrenheit. Substitution of the frost degree day summations shown in figures 2A - 16A were used to compute the corresponding ice growth curves.

Dates of complete ice disintegration and rates of disintegration were estimated for each station primarily from satellite ice data supplemented by historical ice data. It should be stressed that no effort was made to isolate individual factors (e.g., temperature, wind, tidal action, and ocean currents) which affect disintegration. The curves were drawn without attributing disintegration to any one factor and with the assumption that all factors were acting upon the ice at any given time. At one station in particular (Mys Golomyannyy), the estimated date of complete ice disintegration may have wide variance since the primary forces causing ice breakup are local currents and winds rather than thermal processes. A shorelead or open-water area may develop in this area when the ice thickness decreases to 2 or 3 feet if sufficient dynamic pressure is present.

An estimated date for the beginning of permanent ice growth is indicated by a dashed line on the growth curves. A 32°F base is arbitrarily chosen as a standardized starting point to accumulate frost degree days. Since sea water of variable salinities will freeze at temperatures ranging between 29°F and 32°F, the date of initial ice formation is dependent on local salinity values. In addition, day-to-day temperatures at some stations may oscillate above or below this 32°F-29°F base causing initial ice of a temporary nature to form. At stations where wind or wave action is present during the freezeup period, this new ice can be broken up shortly after formation. Initial ice formation may also be inhibited by constant agitation by wind or wave action. At any given station, this procedure may recur several times within a relatively short period until the temperature drops well below 29°F and continues to decrease. The ice will then attain a sufficient thickness so that it will not be adversely affected by wind or wave agitation.

Use of Zubov's equation for constructing the curves contained in this report was tested by comparing empirical North American Arctic ice data for 5 stations shown in TR-60(2) with ice thickness values obtained by using Zubov's equation. The percentage differences between these two values were computed for one thousand degree day increments; results are listed in table 2. Of the 44 comparisons, 43 are within the percent difference range of 0.4 to 9.8. These comparisons support the use of the Zubov equation.

III. Application

The curves presented in this report can be used in the absence of measured ice observations to predict ice thickness for a specific locality along the northern Russian coast. Temperature data obtained from synoptic weather reports received from this area or predictions of air temperature are first transformed into frost degree day accumulations. These accumulations can then be used in conjunction with the theoretical ice growth curves to estimate ice thickness for any desired location. Indications of abnormally good or bad ice conditions can also be made on the basis of the deviation of the degree day curve from normal.

These results complement and extend previous work reported by Kniskern and Potocsky (2), which included ice thickness curves for 52 locations in the North American Arctic. Together, these two reports comprise nearly comprehensive coverage of arctic or subarctic coastal areas for which ice thickness forecasts might be desired.

REFERENCES

1. Zubov, N. N., On the Maximum Thickness of Sea Ice of Many Years Growth, Meteorologiia i Gidrologiia 4, 1938, pp 123-131

2. Kniskern, F. E. and G. J. Potocsky, Frost Degree Day, Related Ice Thickness Curves, and Harbor Freezeup and Breakup Dates for Selected Arctic Stations, Naval Oceanographic Office, TR-60, 123 pp, 1965

TABLE 2

Comparison Ice Thickness Values From TR-60 Empirical Curves and Values Obtained From Zubov Equation

ICE THICKNESS IN INCHES AND % DIFFERENCE

FROST DEG. DAYS	ZUBOV	THULE	% DIFF	RESOLUTE BAY	% DIFF	MOULD BAY	% DIFF	ISACHSEN	% DIFF	ALERT	% DIFF
1000	18.3 in			17.0 in	7.1%	17.0 in	7.1%	22.0 in	20.2%	18.5 in	1.1%
2000	28.7	27.5	4.2	26.5	7.7	31.5	9.8	31.0	8.0	27.0	5.9
3000	36.9	36.0	2.4	34.0	7.9	40.5	9.8	39.0	5.7	39.5	7.0
4000	43.8	42.0	4.1	40.0	8.7	47.0	7.3	46.0	5.0	47.0	7.3
5000	50.0	52.0	4.0	45.5	9.0	53.0	6.0	52.0	4.0	54.0	8.0
6000	55.5	58.0	4.5	52.0	6.3	58.5	5.4	58.0	4.5	58.5	5.4
7000	60.7	63.0	3.8	57.5	5.3	65.5	7.9	64.0	5.4	62.5	3.0
8000	65.5	67.0	2.3	61.0	6.9	70.5	7.6	71.0	8.4	67.0	2.3
9000	70.7	71.0	0.4	65.0	8.1	73.5	4.0	76.0	7.5	71.0	0.4

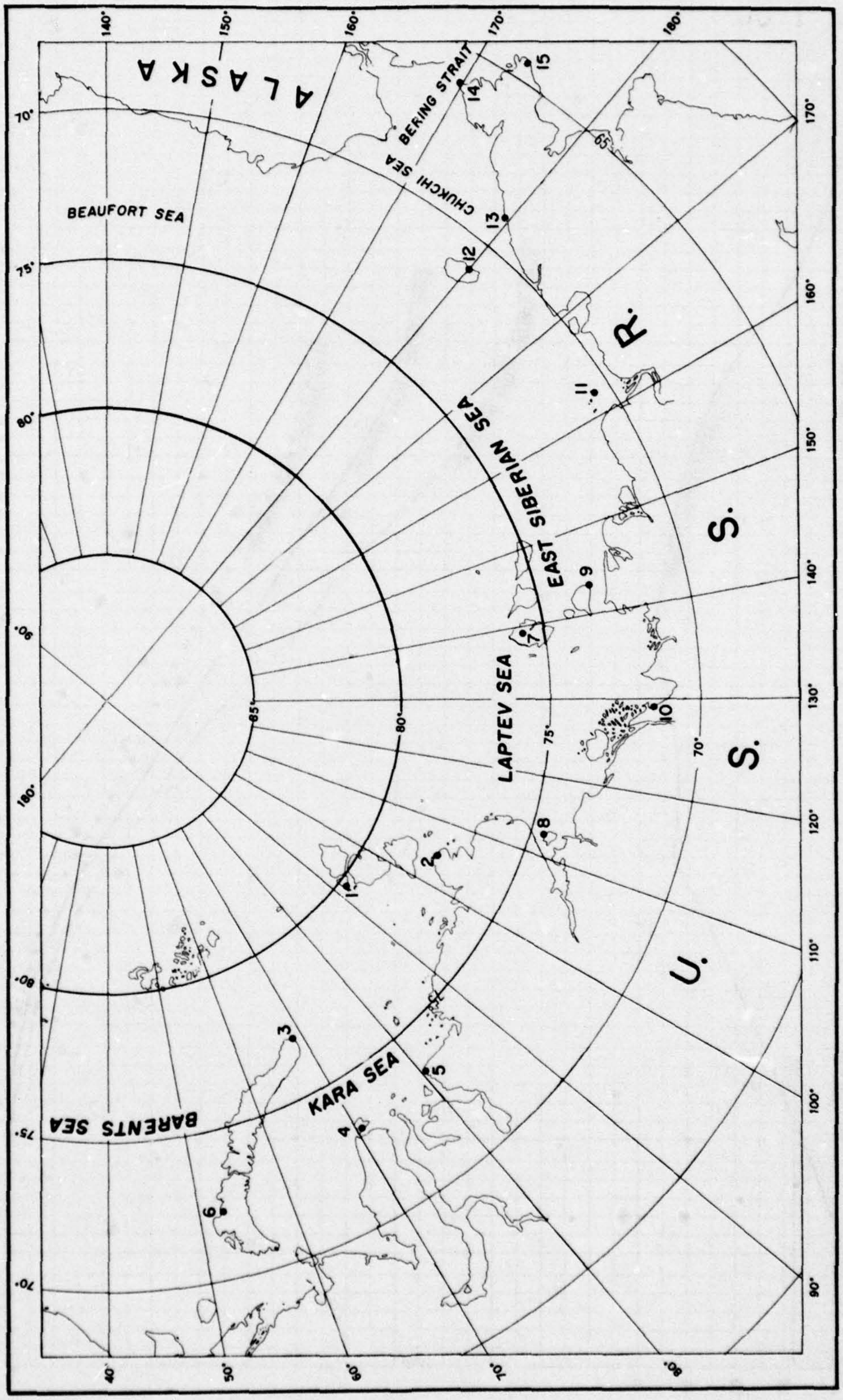


FIGURE 1 LOCATION MAP FOR FROST DEGREE DAY AND ICE GROWTH AND DISINTEGRATION CURVES

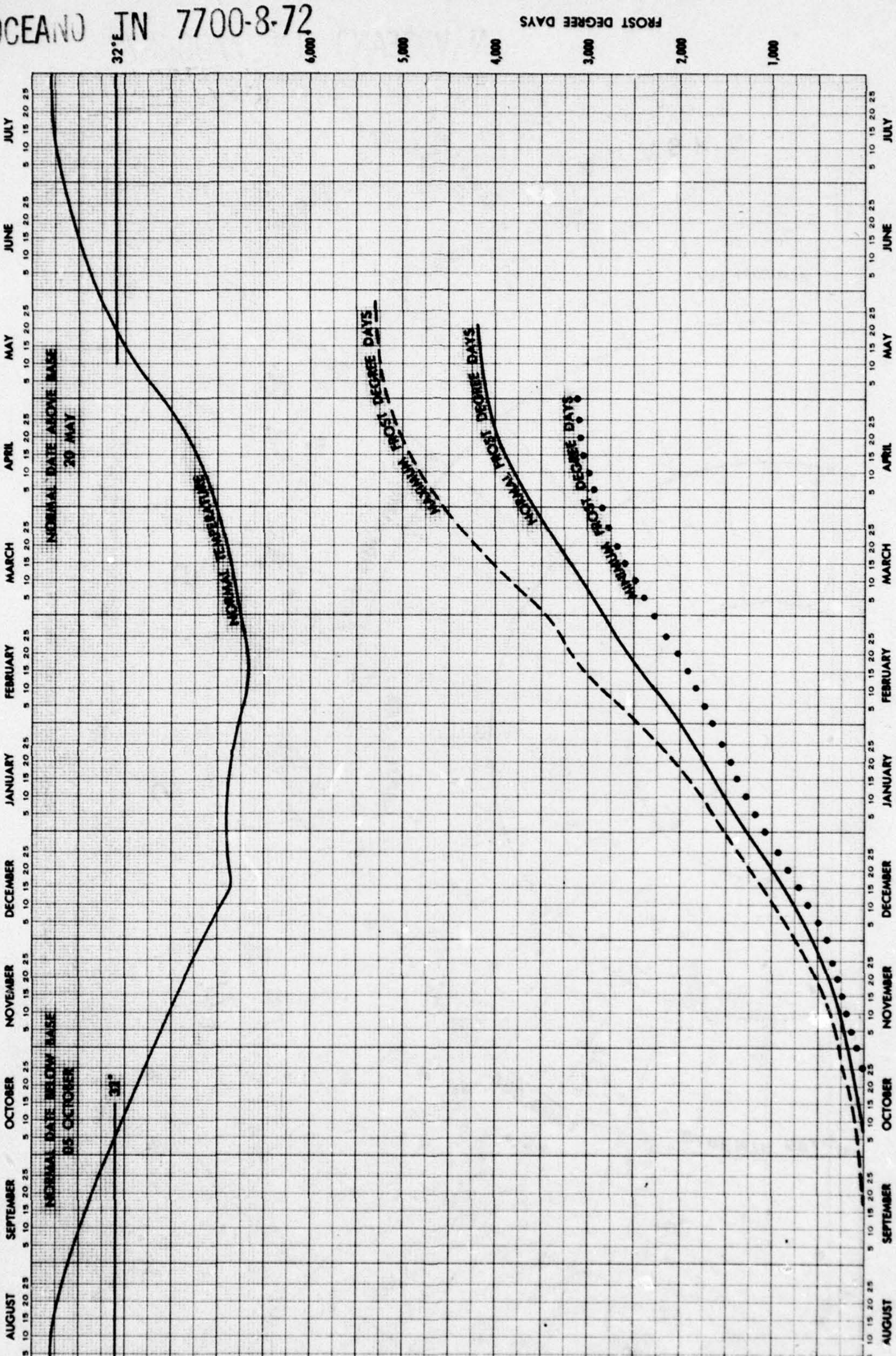


FIGURE 2A BUKHTA PROVIDENIYA (13 YEARS RECORD)

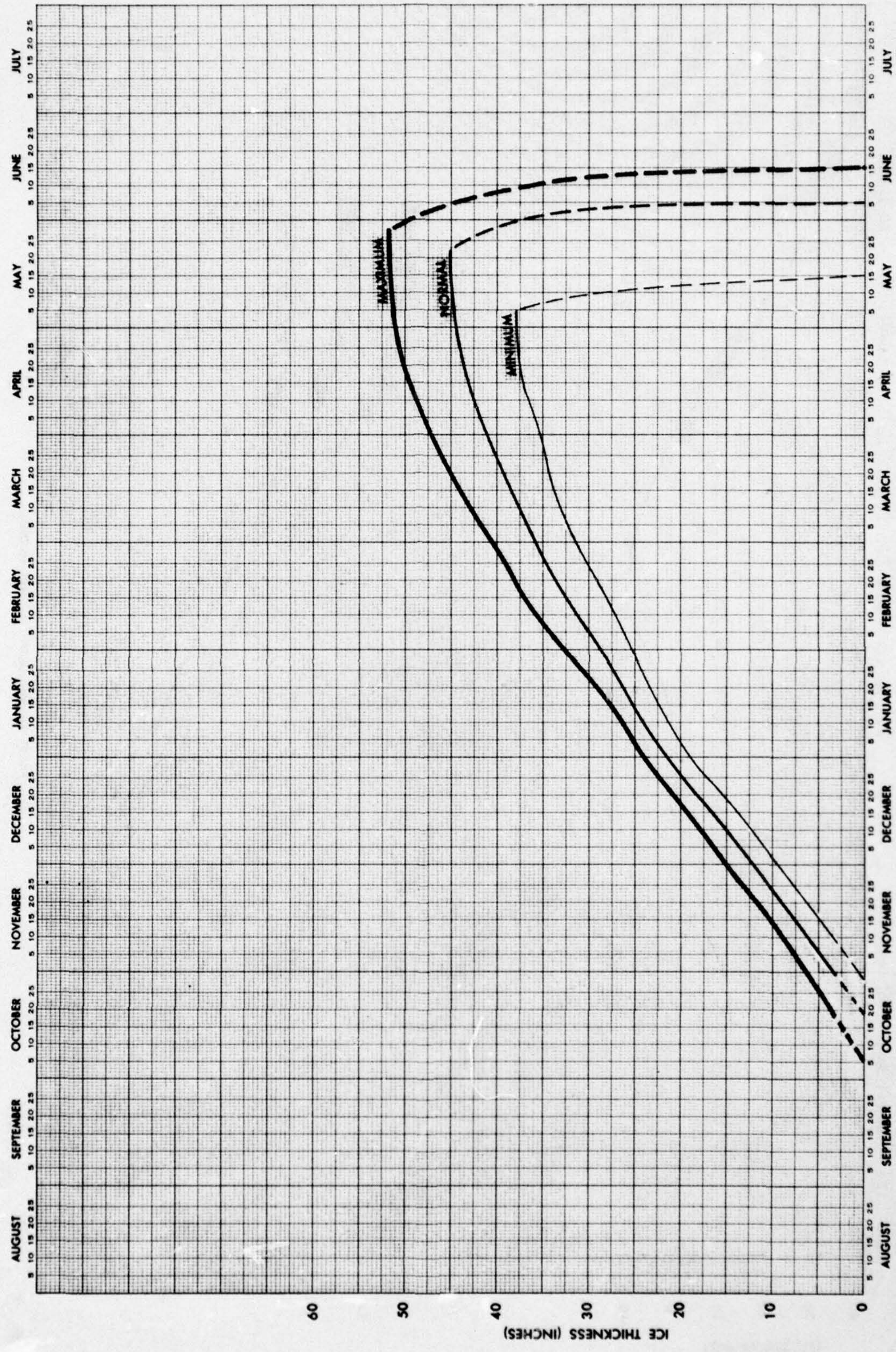


FIGURE 28 BUKHTA PROVIDENIYA THEORETICAL ICE GROWTH AND ESTIMATED DISINTEGRATION CURVES

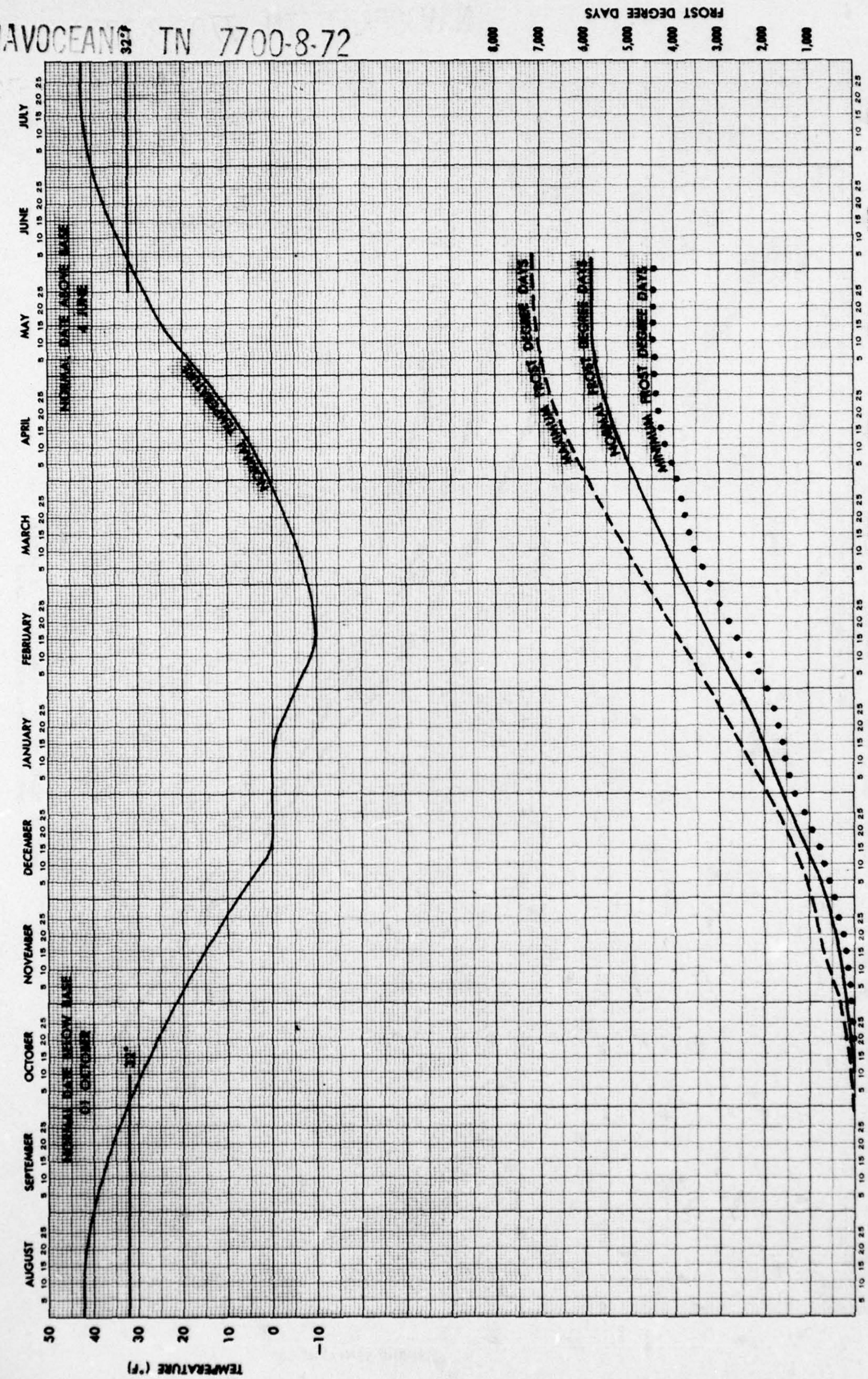


FIGURE 3A MYS UELEN (13 YEARS RECORD)

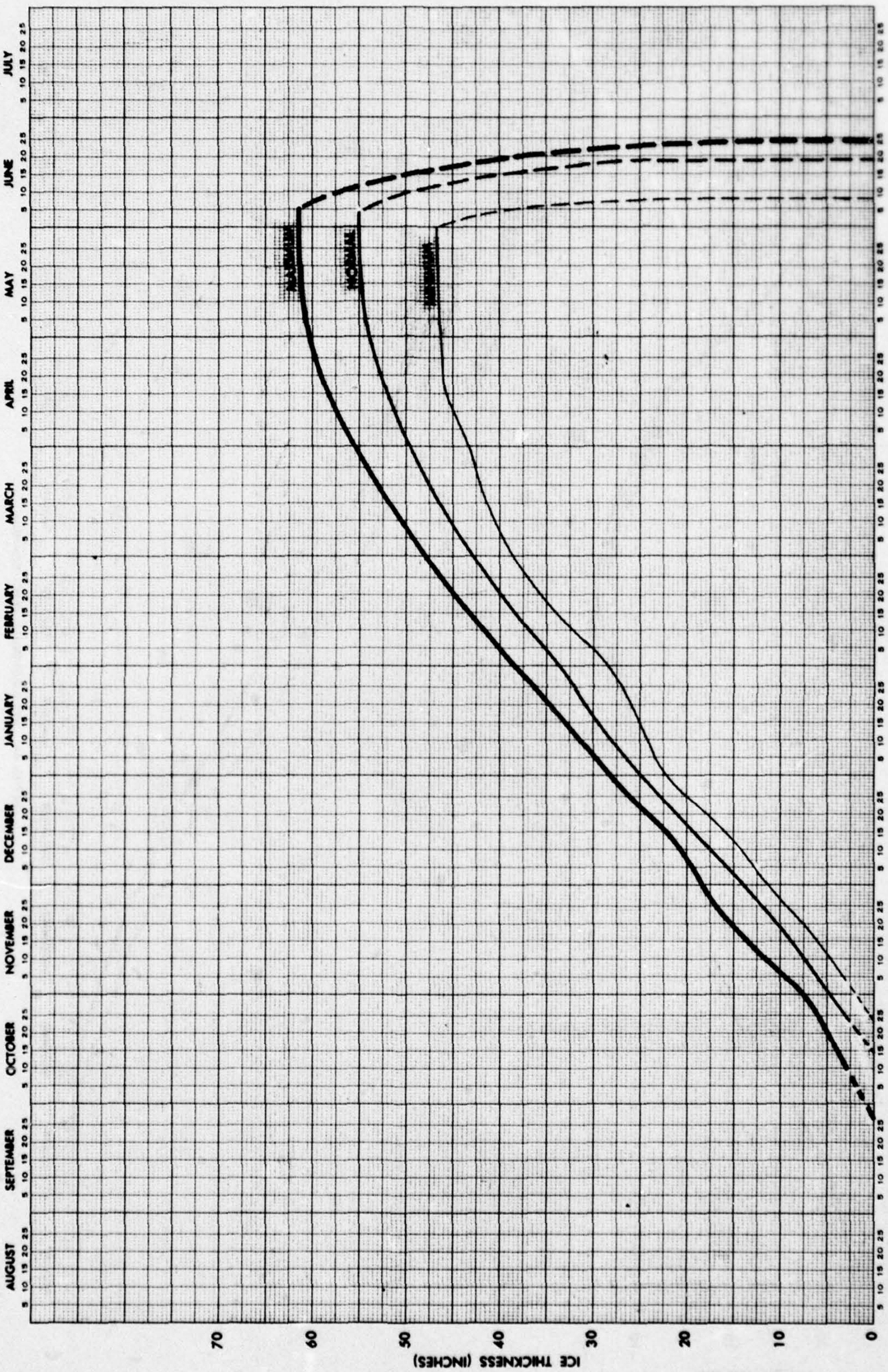


FIGURE 38 MYS UELEN THEORETICAL ICE GROWTH AND ESTIMATED DISINTEGRATION CURVES

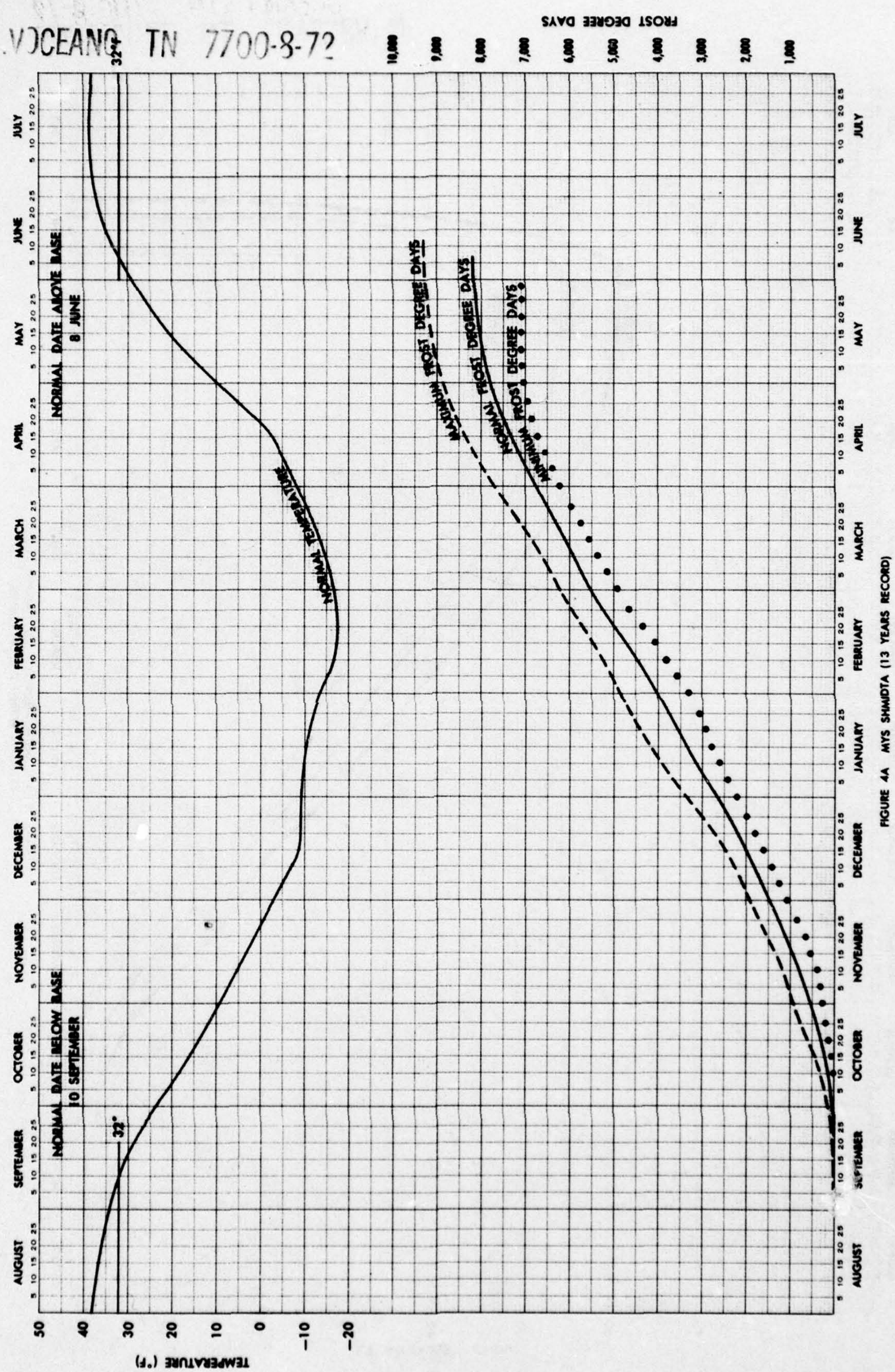


FIGURE 4A MYS SHMIDTA (13 YEARS RECORD)

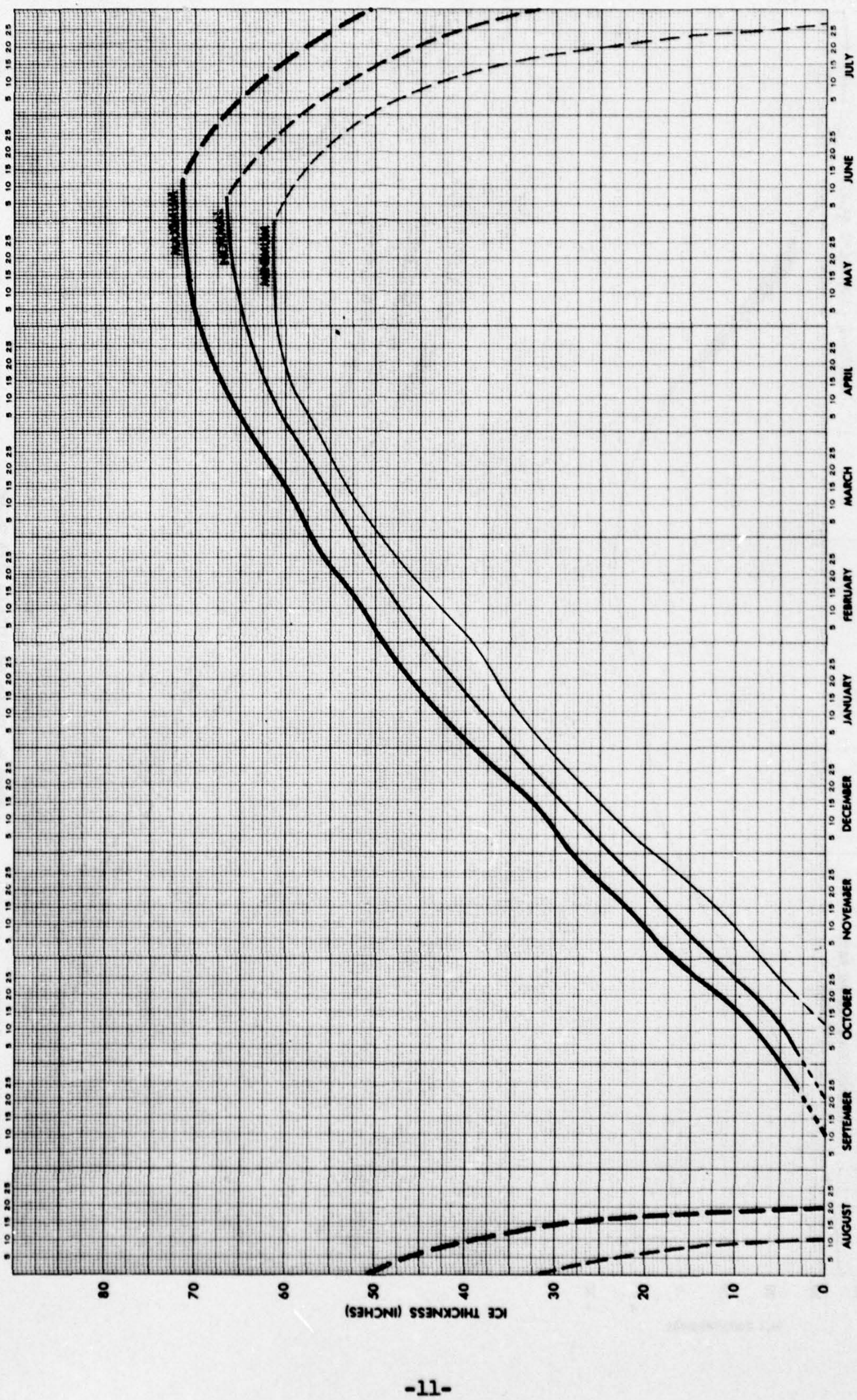


FIGURE 48 MYS SHMIDTA THEORETICAL ICE GROWTH AND ESTIMATED DISINTEGRATION CURVES

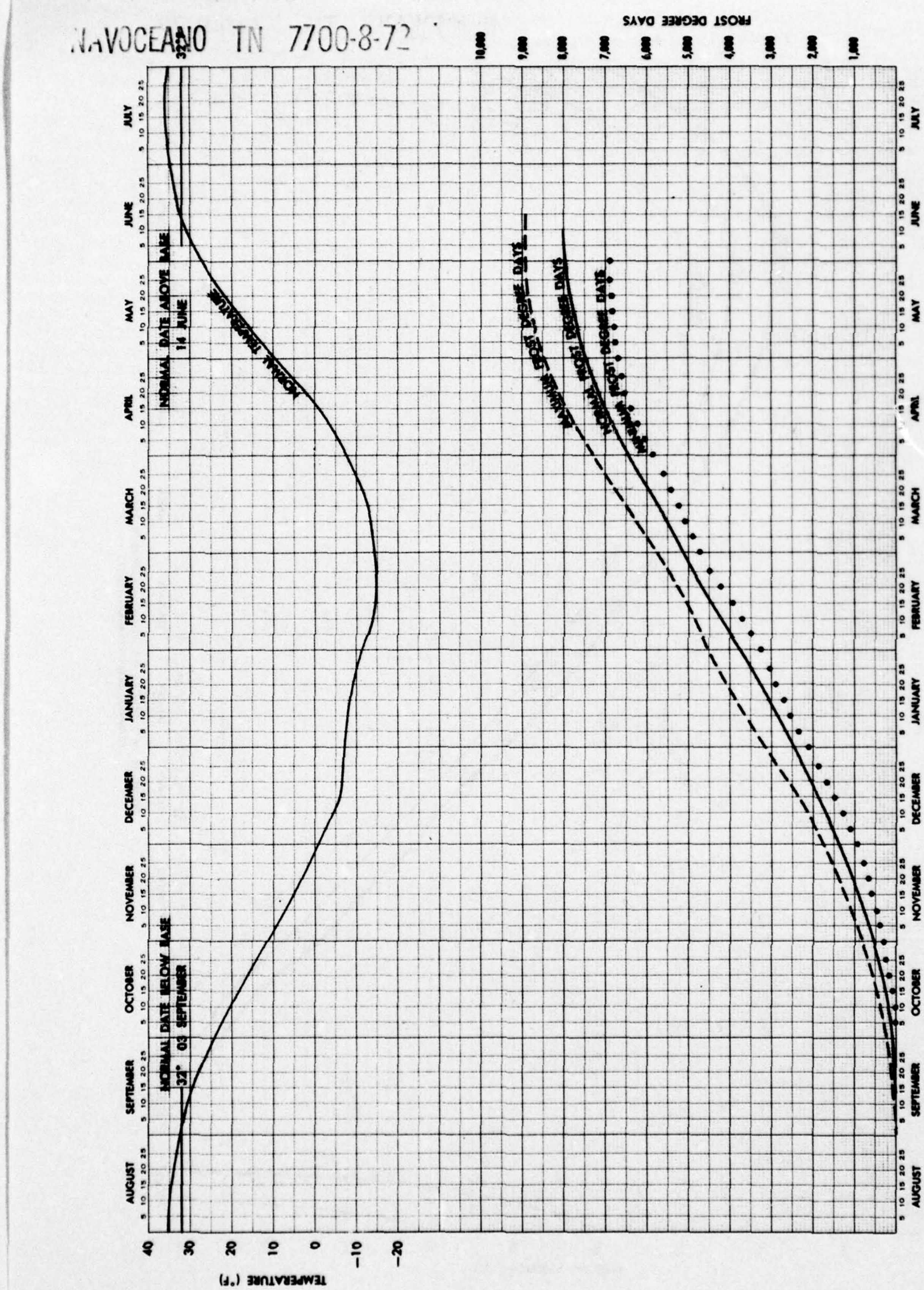


FIGURE 5A OSTROV VRANGELYA (13 YEARS RECORD)

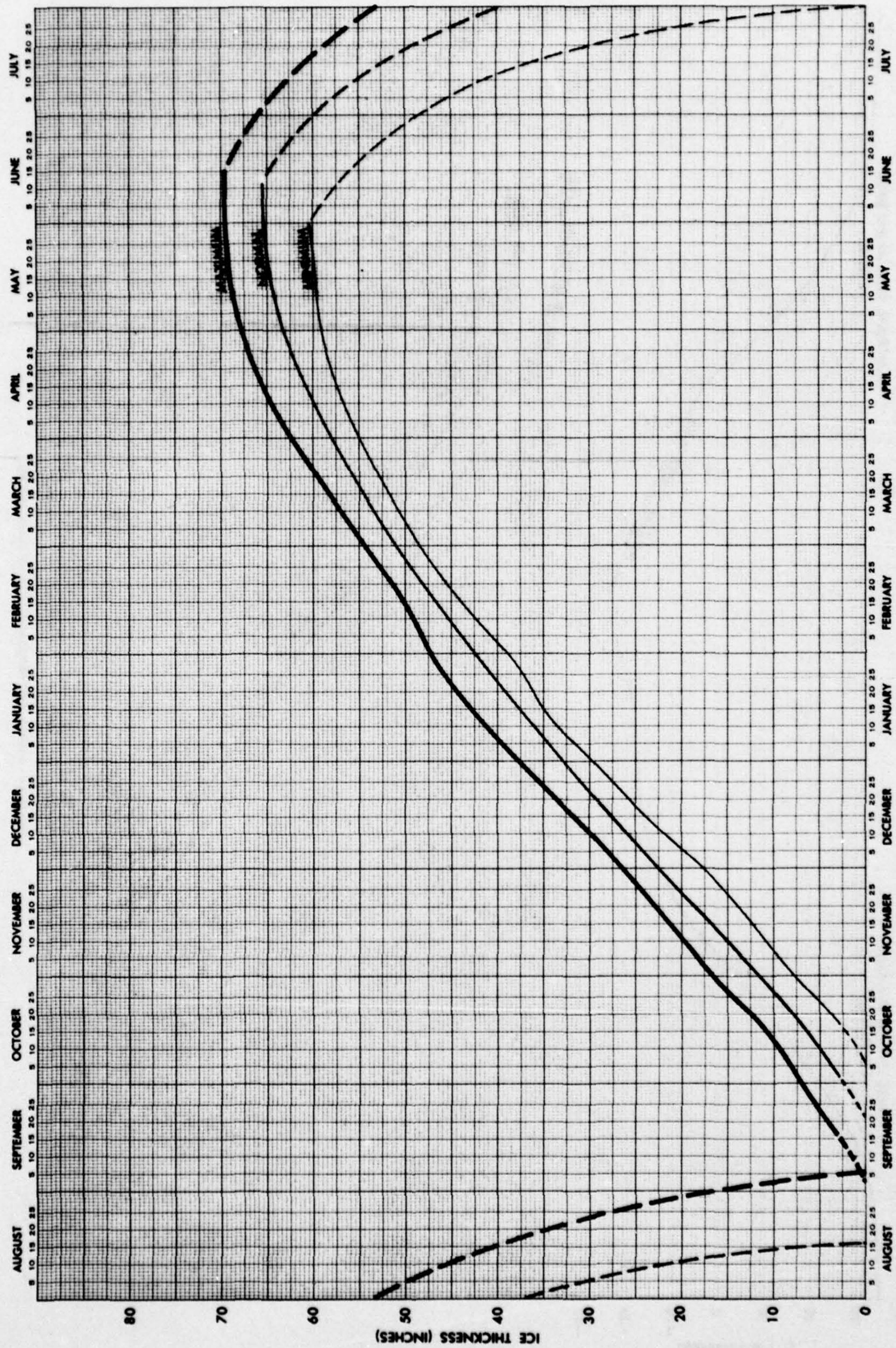


FIGURE 58 OSTROV VRANGELYA THEORETICAL ICE GROWTH AND ESTIMATED DISINTEGRATION CURVES

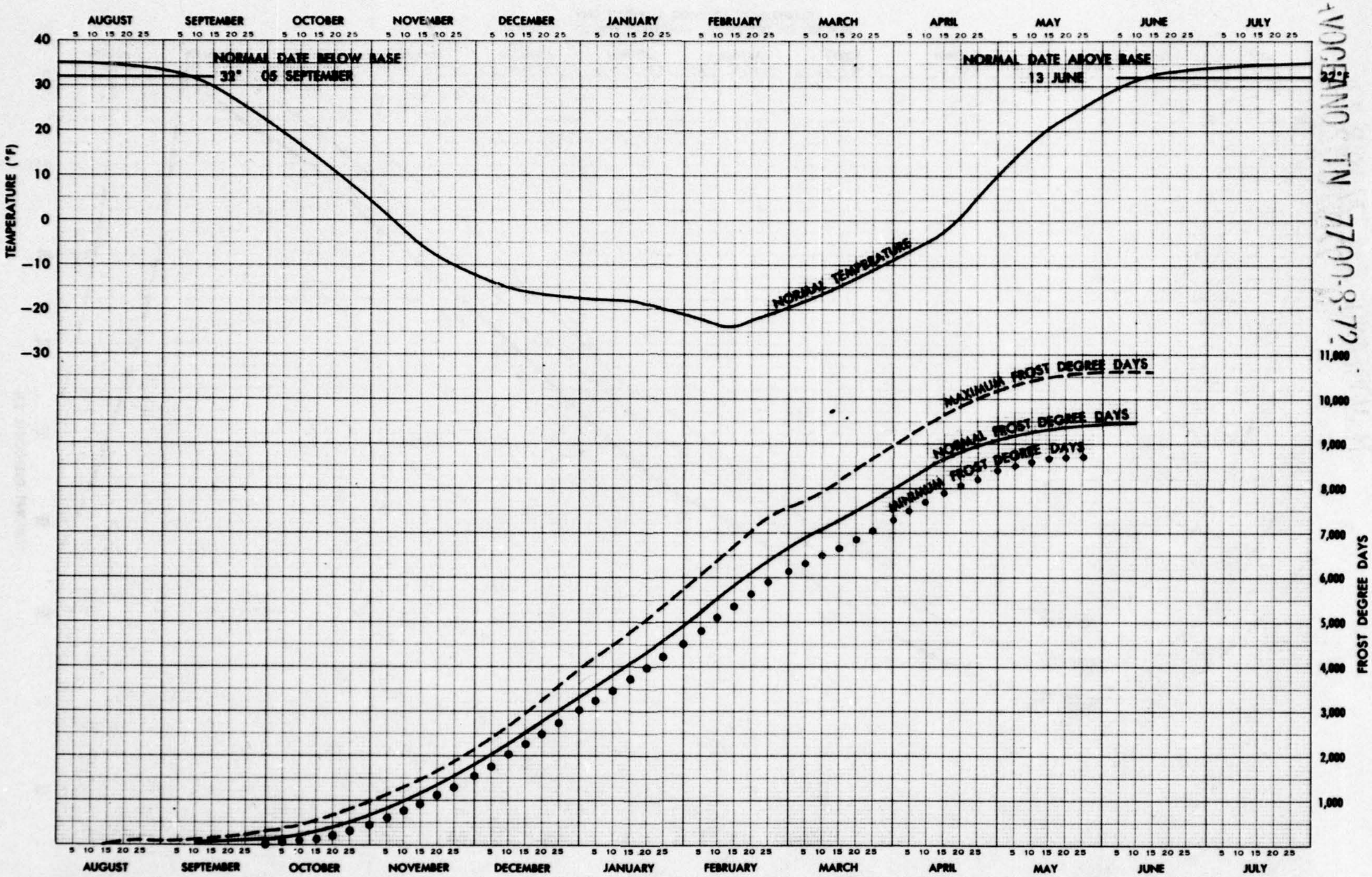


FIGURE 6A OSTROV CHETYREKHSTOLBOVOY (6 YEARS RECORD)

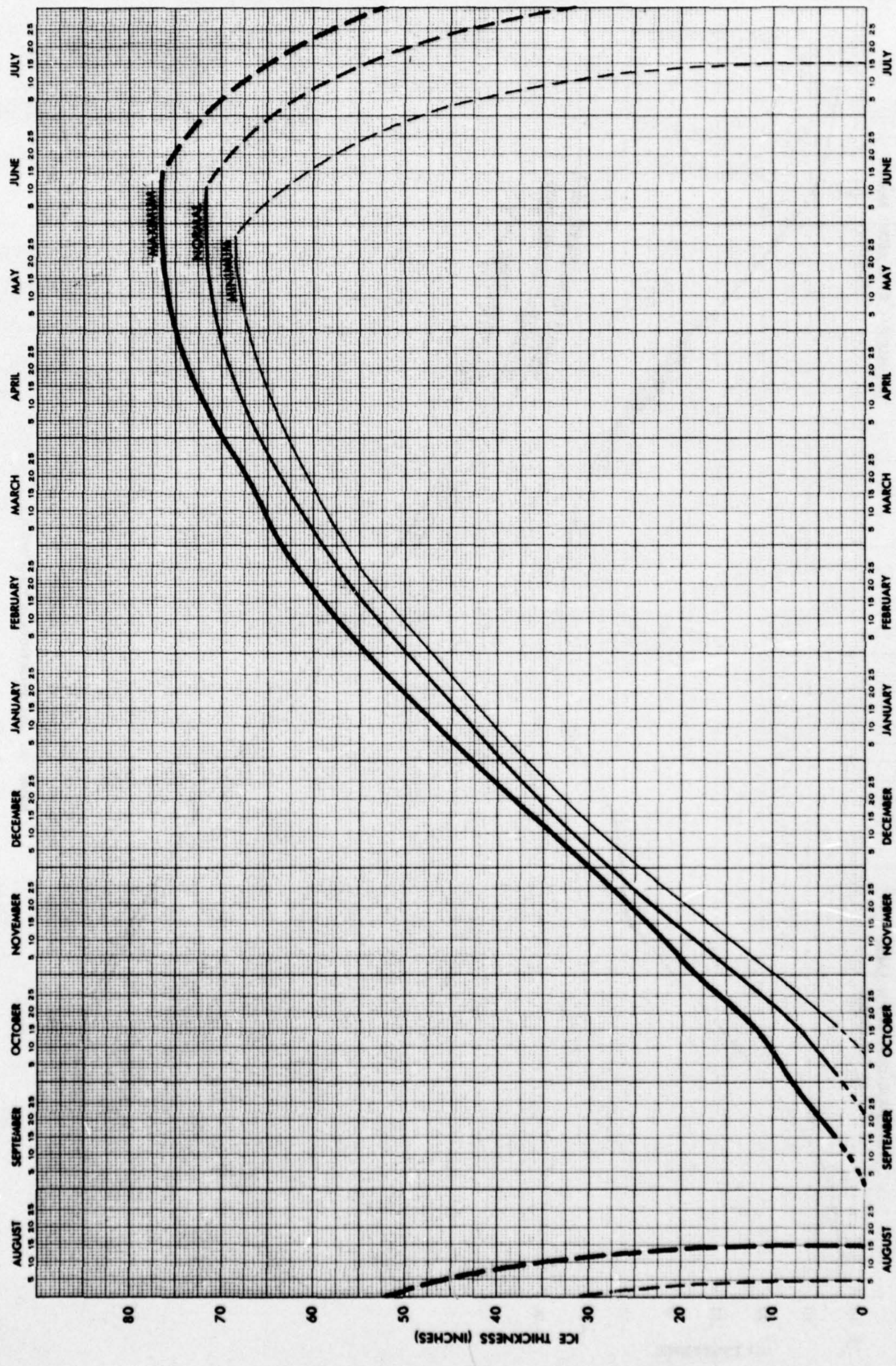


FIGURE 68 OSTROV CHETYREKHSTOLBOVOY THEORETICAL ICE GROWTH AND ESTIMATED DISINTEGRATION CURVES

N.VOCEANO TN 7700-8-72

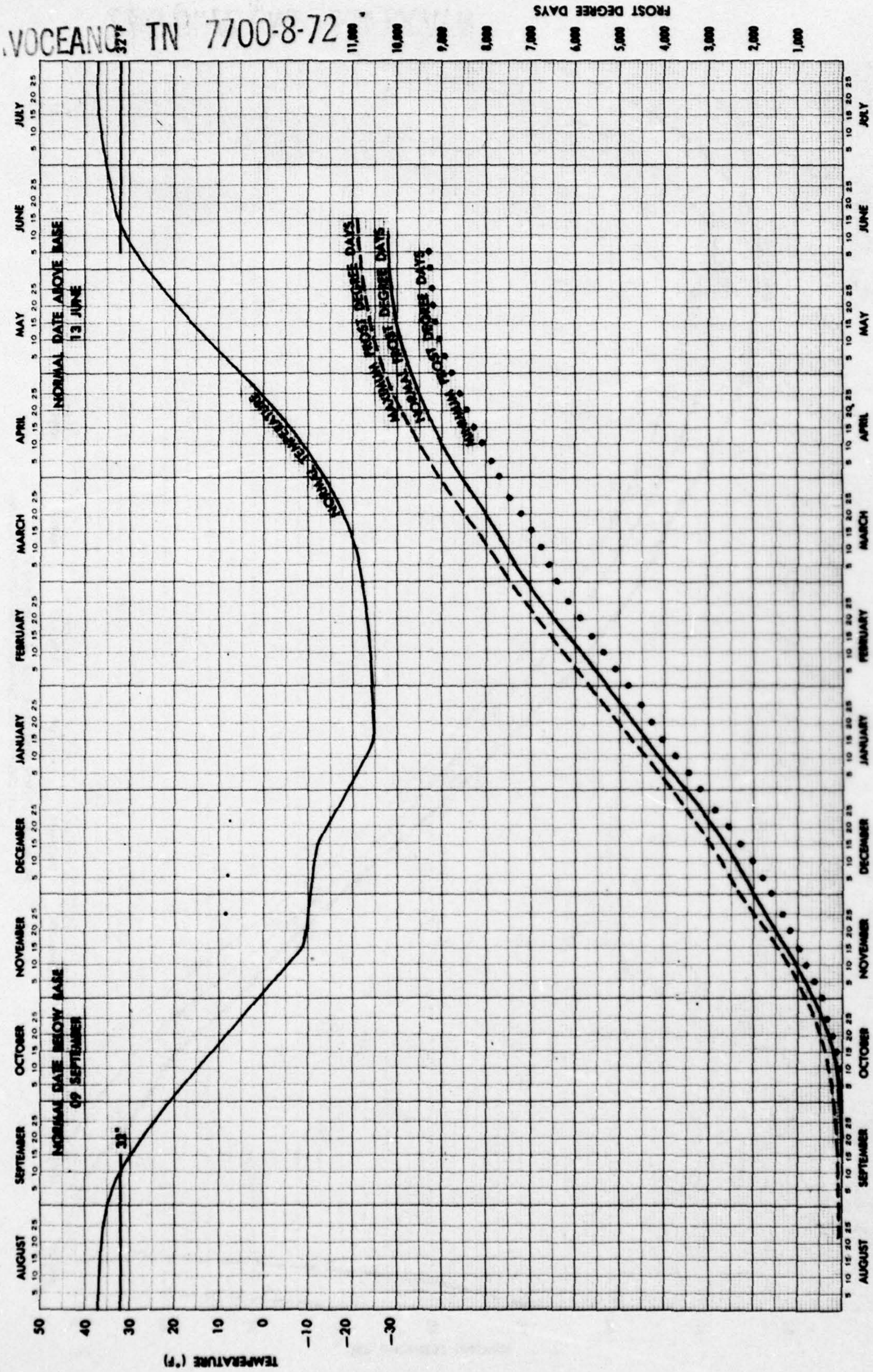


FIGURE 7A MYS SHALAUROVA (6 YEARS RECORD)

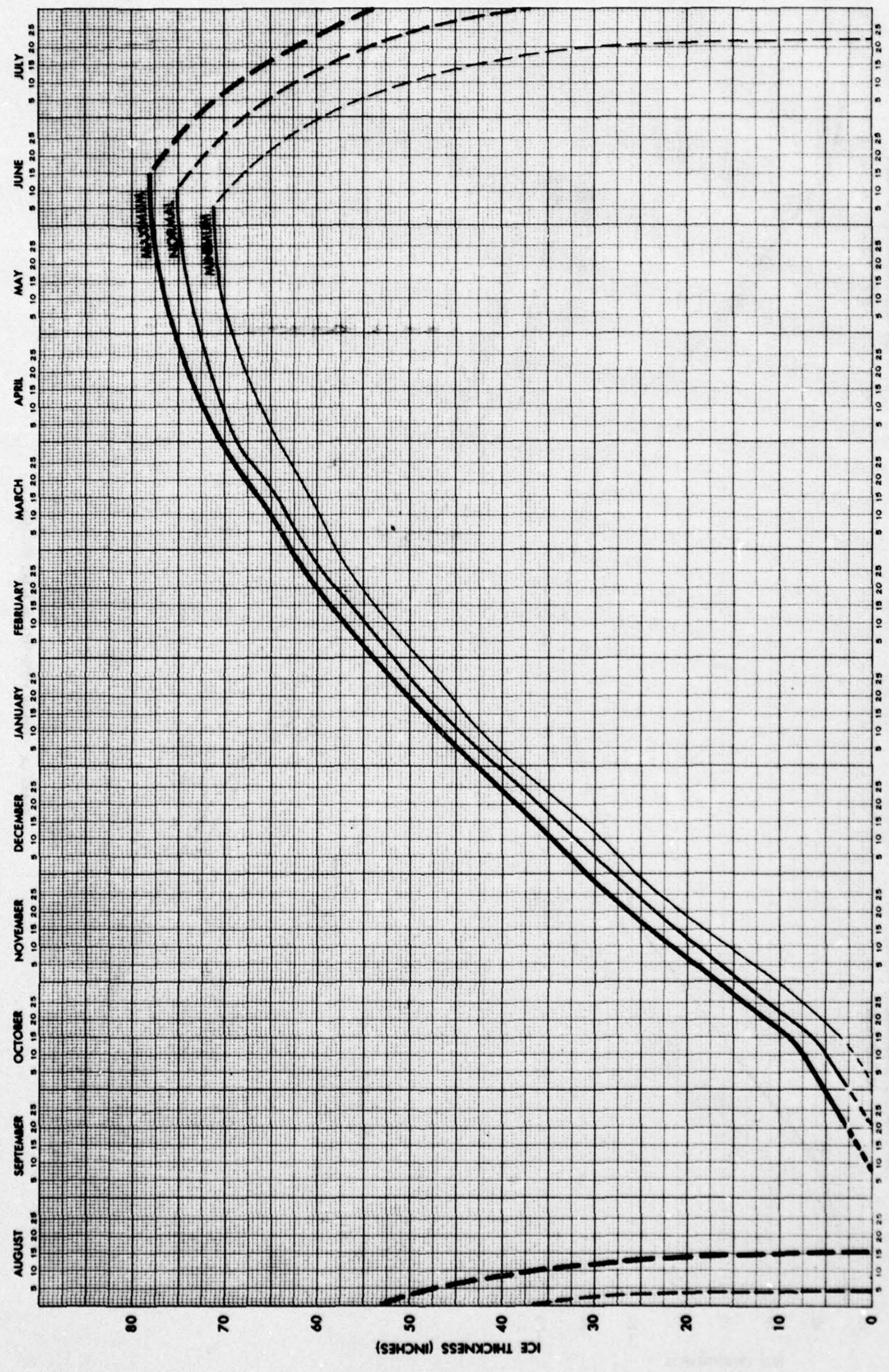


FIGURE 7B MYS SHALAUROVA THEORETICAL ICE GROWTH AND ESTIMATED DISINTEGRATION CURVES

N V)CEANO TN 7700-8-72

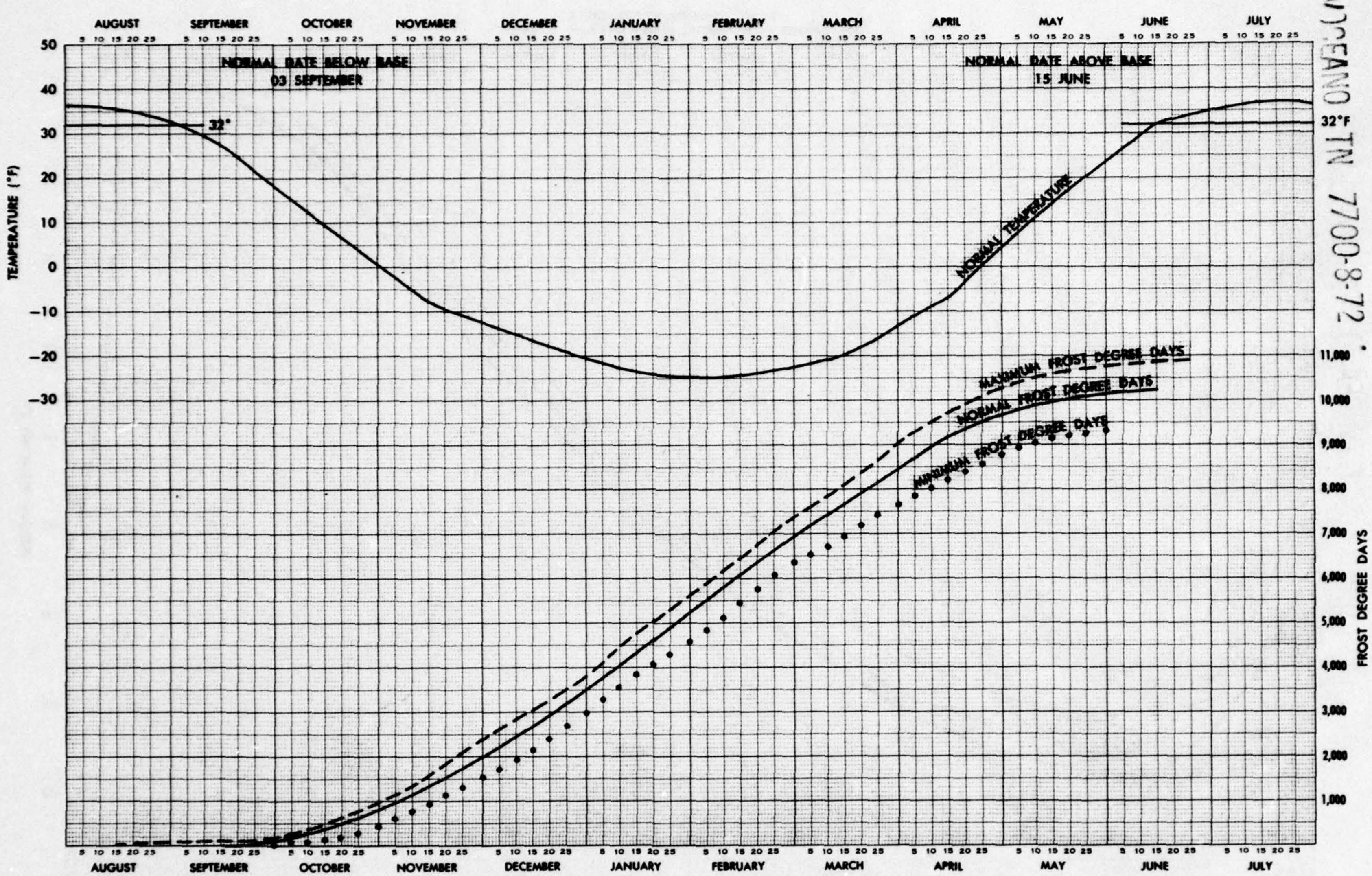


FIGURE 8A OSTROV KOTEL'NYY (6 YEARS RECORD)

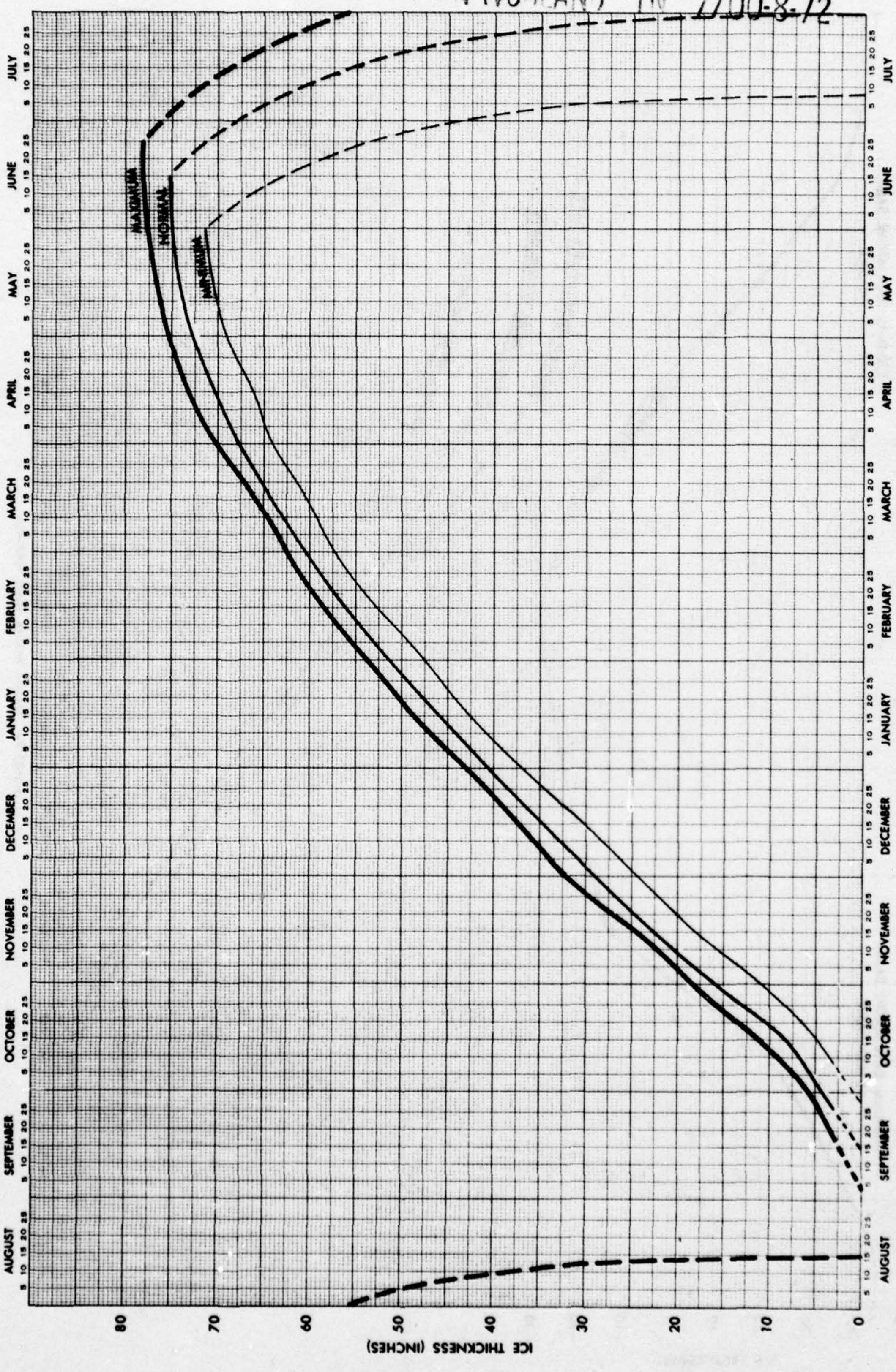


FIGURE 88 OSTROV KOTEL'NYY THEORETICAL ICE GROWTH AND ESTIMATED DISINTEGRATION CURVES

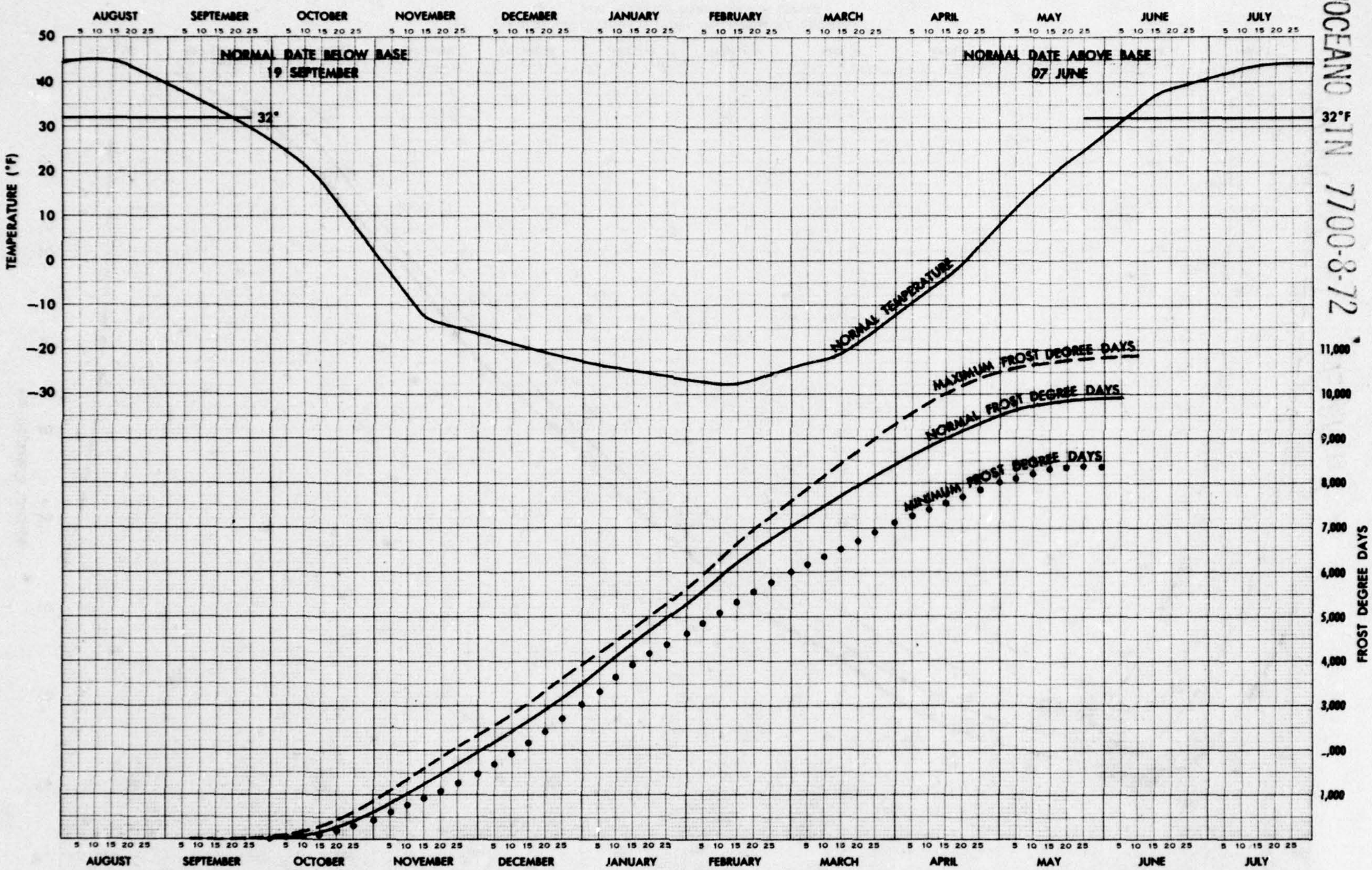


FIGURE 9A BUKHTA TIKSI (6 YEARS RECORD)

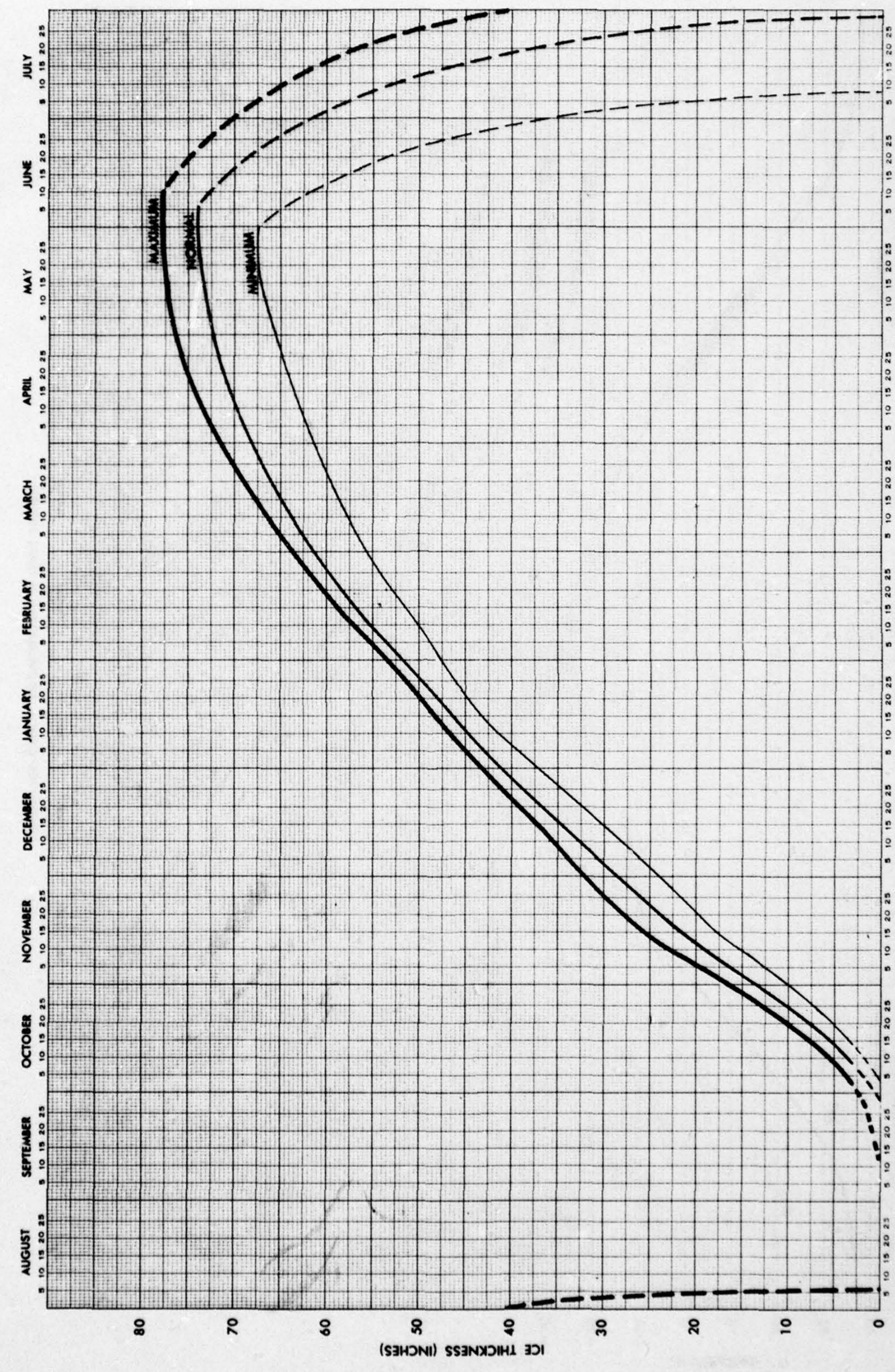


FIGURE 9B BUKHTA TIKSI THEORETICAL ICE GROWTH AND ESTIMATED DISINTEGRATION CURVES

NAVOCEANO TN 7700-8-72

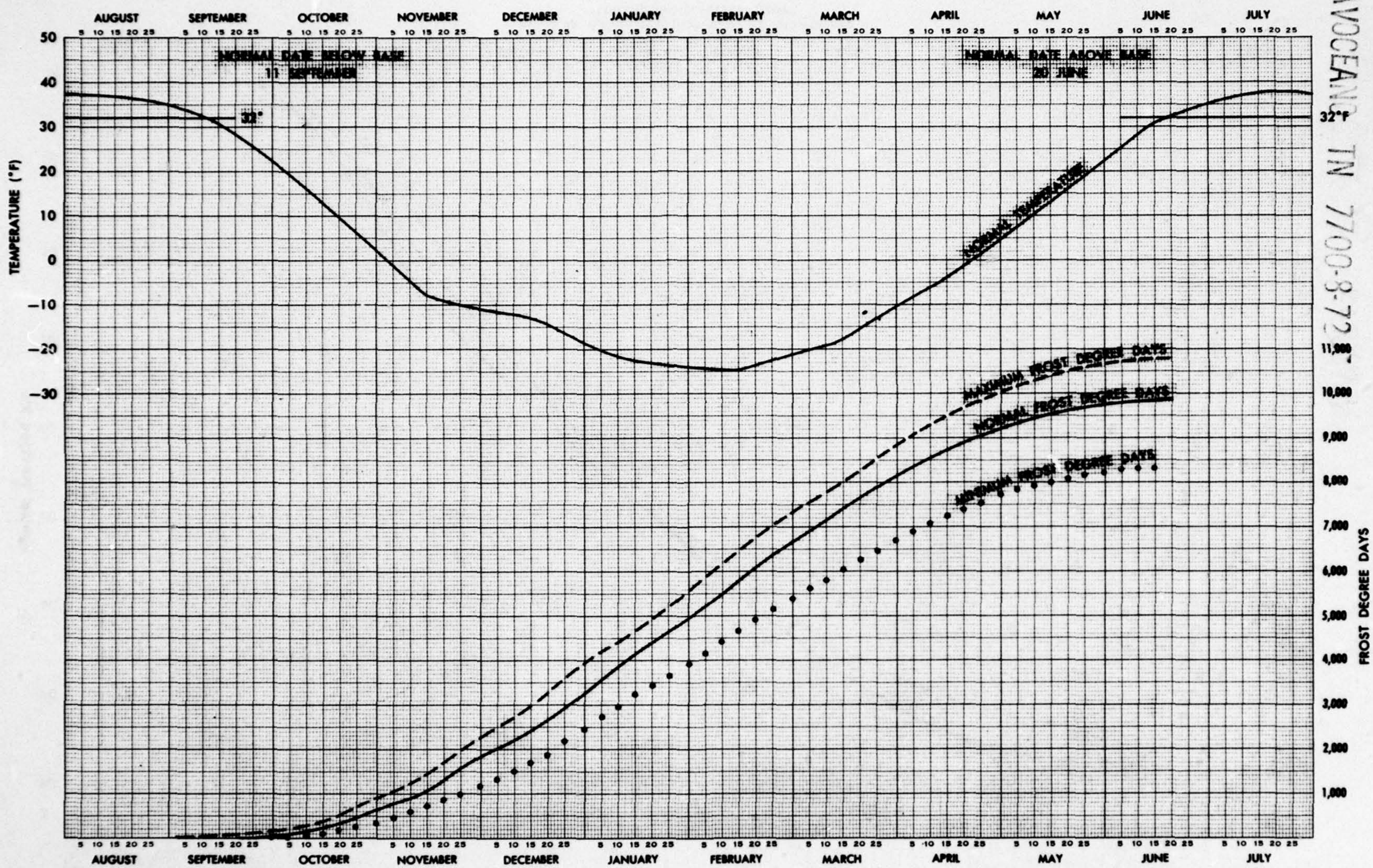


FIGURE 10A OSTROV PREDBRAZHENIYA (6 YEARS RECORD)

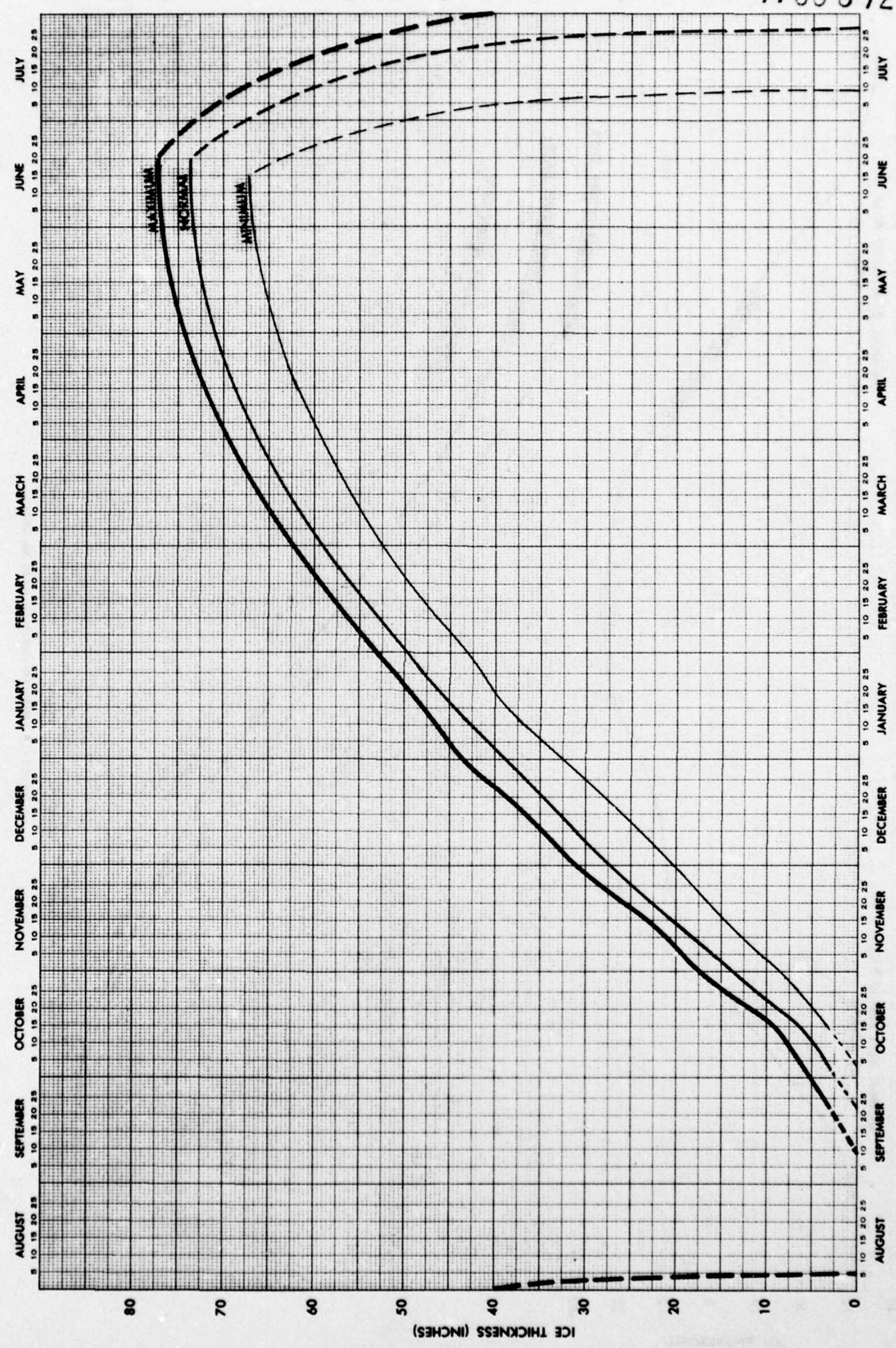


FIGURE 10B OSTROV PREOBRAZHENIYA THEORETICAL ICE GROWTH AND ESTIMATED DISINTEGRATION CURVES

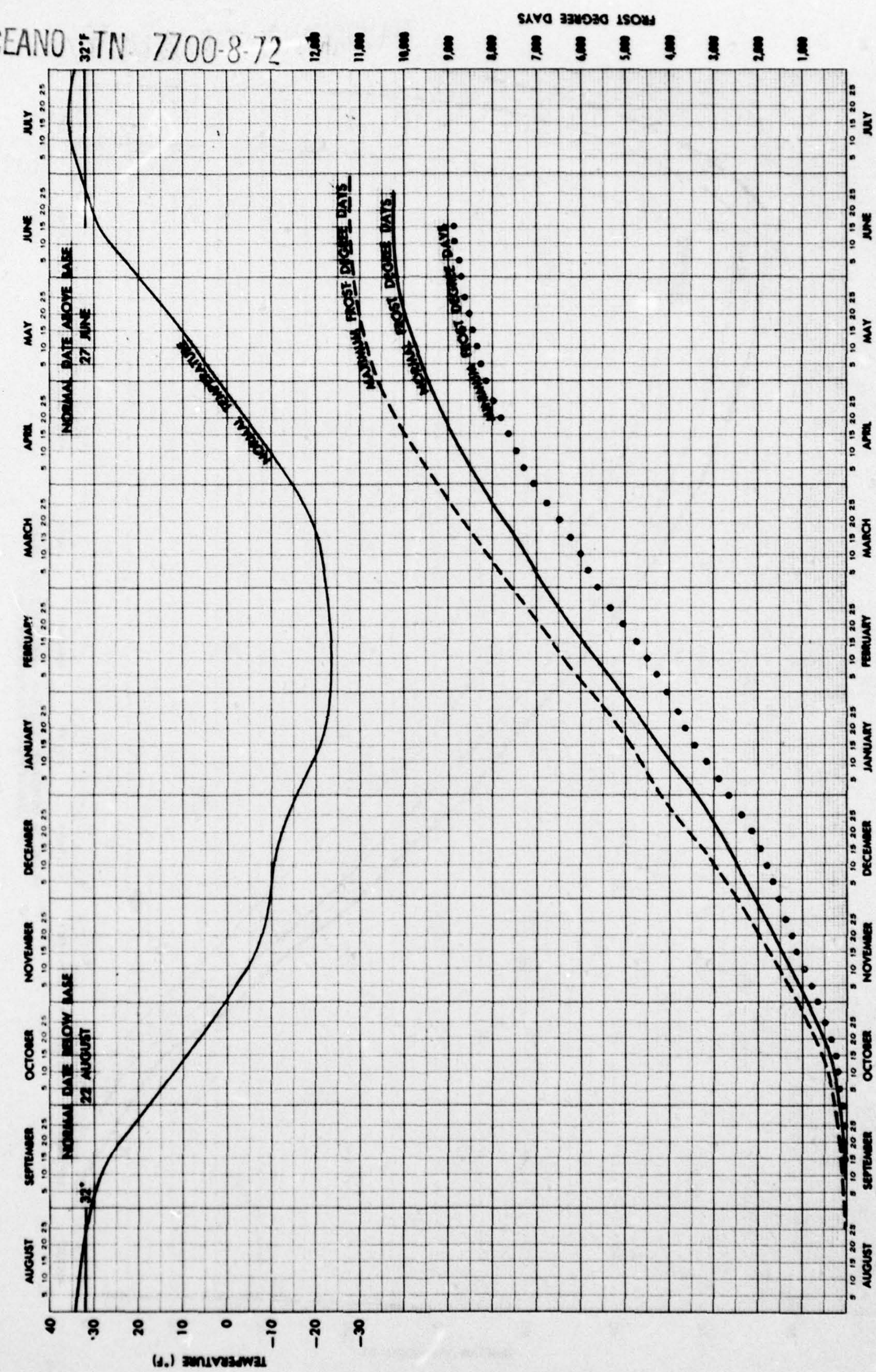


FIGURE 11A MYS CHELYUSKIN (6 YEARS RECORD)

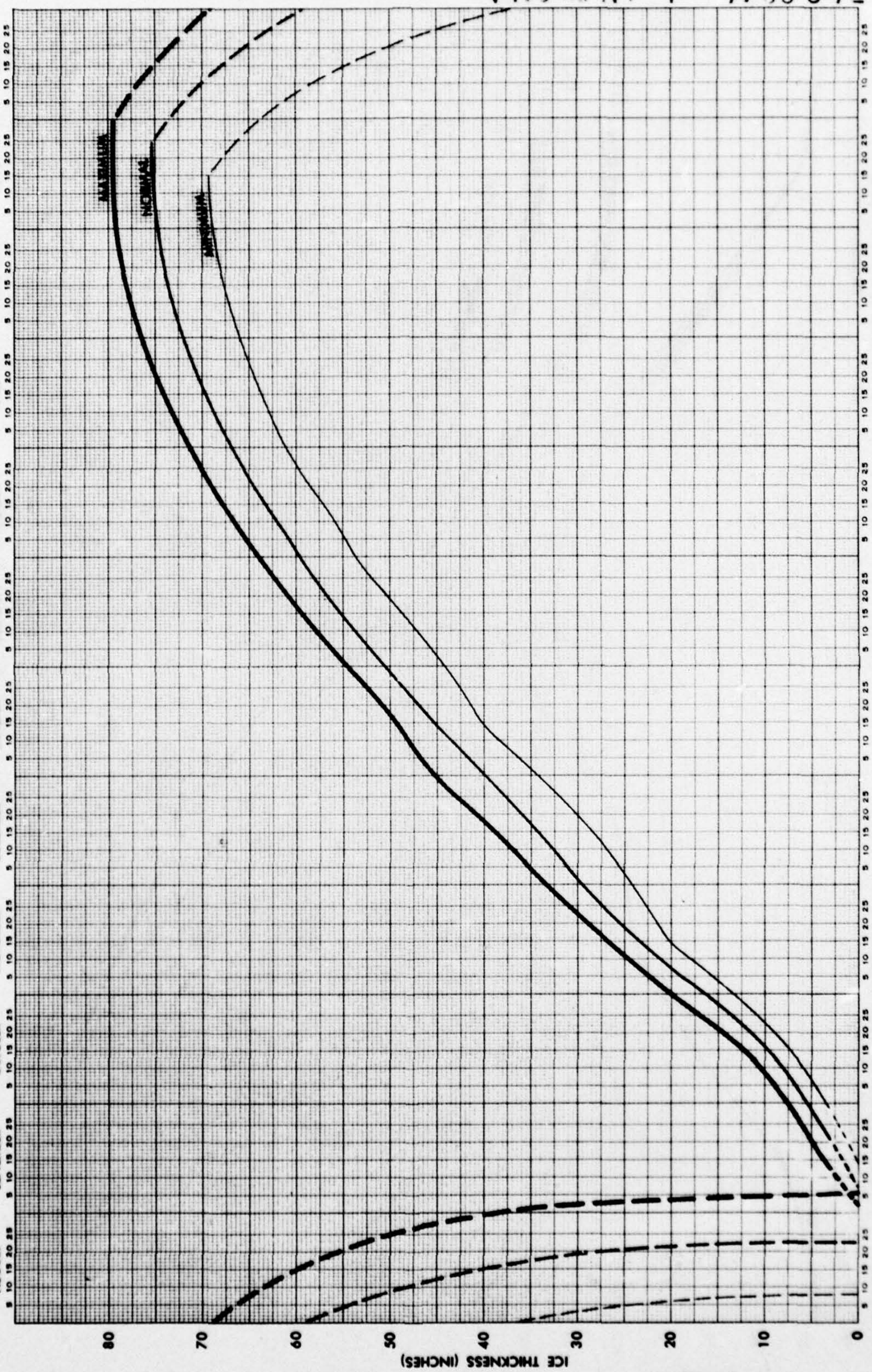


FIGURE 11B MYS CHELYUSKIN THEORETICAL ICE GROWTH AND ESTIMATED DISINTEGRATION CURVES

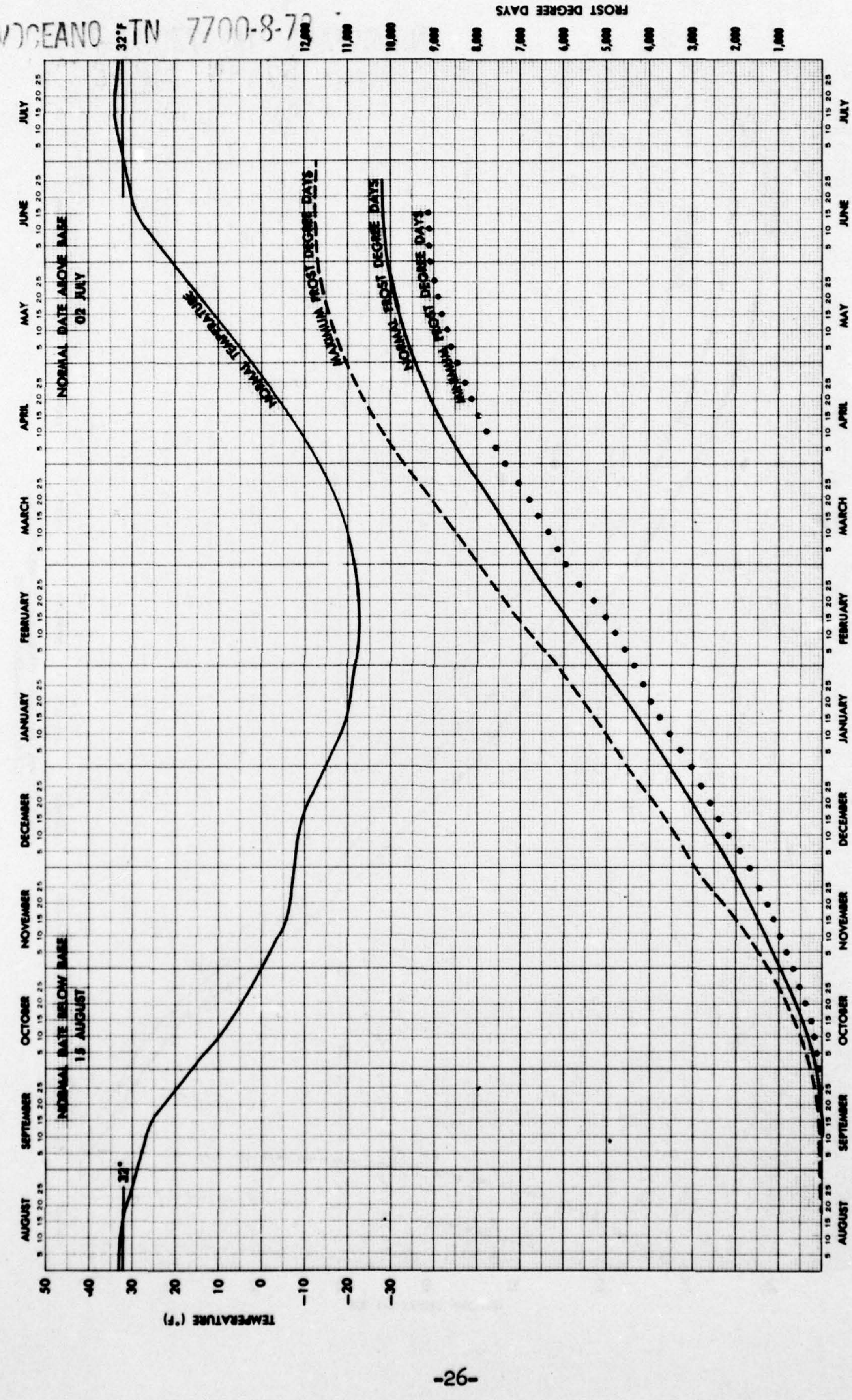


FIGURE 12A MYS GOLOMYANNYY (6 YEARS RECORD)

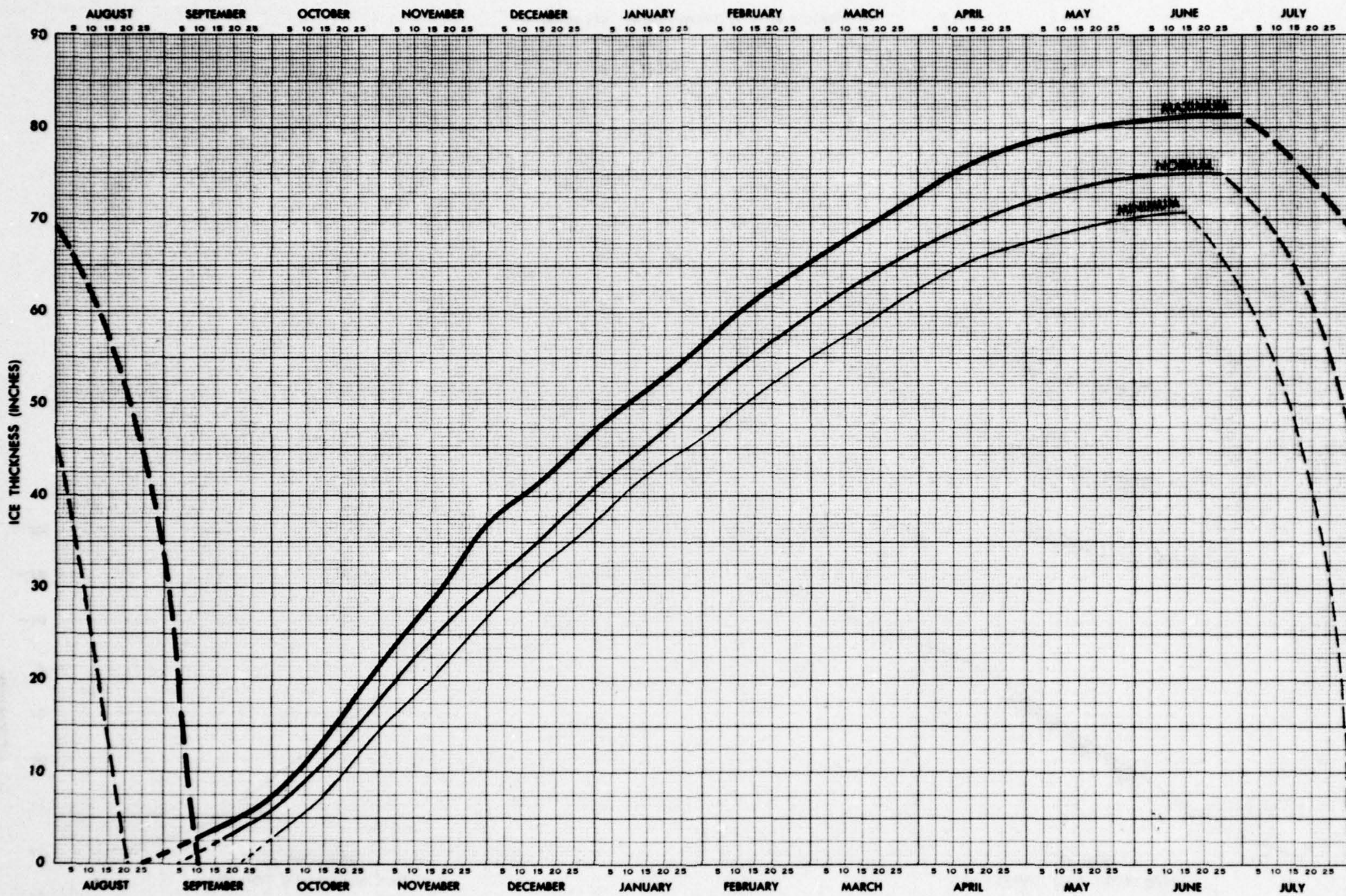


FIGURE 12B MYS GOLOMYANNYY THEORETICAL ICE GROWTH AND ESTIMATED DISINTEGRATION CURVES

N.AVOCEANO TN 7700-8-72

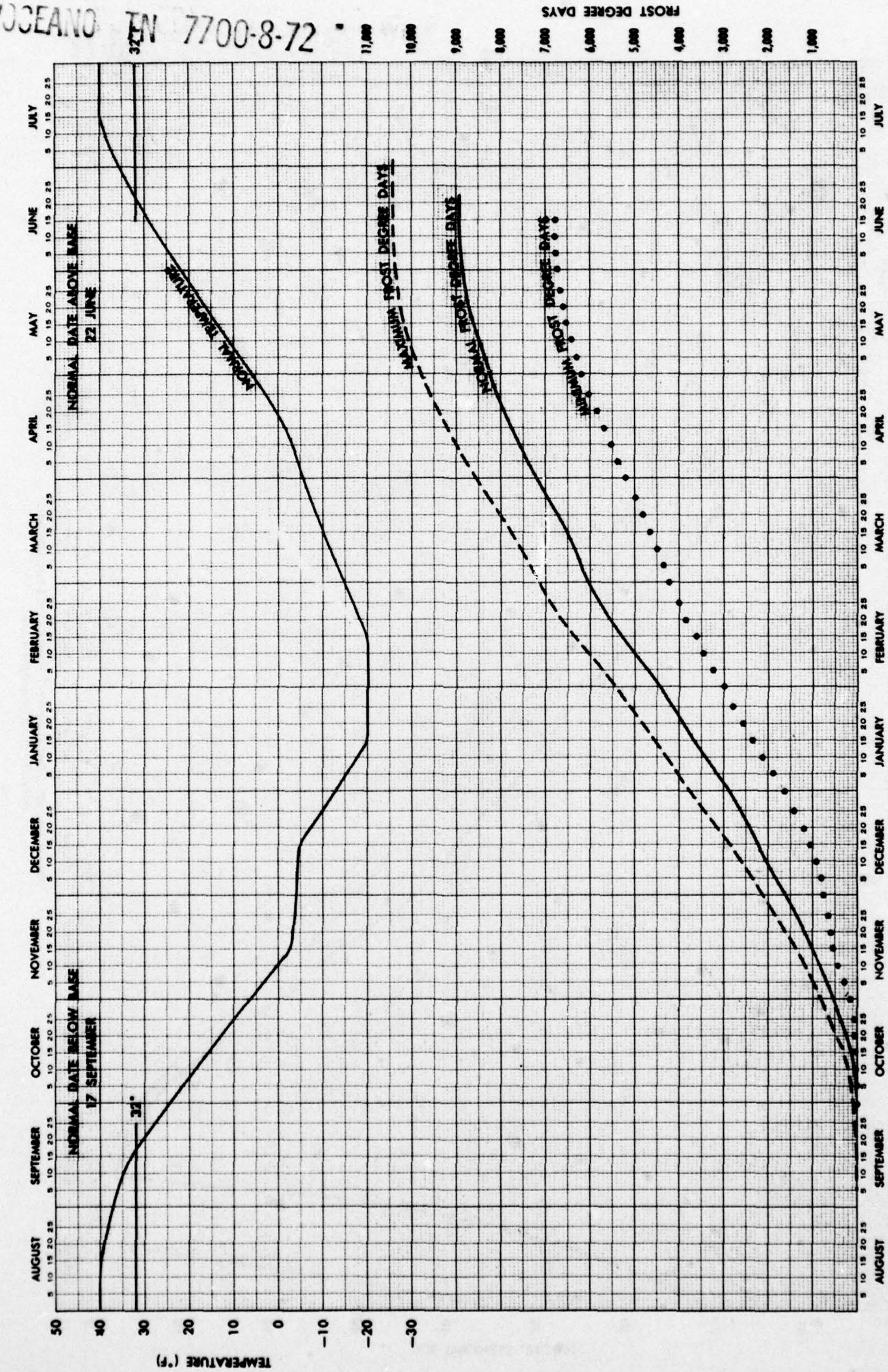


FIGURE 13A OSTROV DIKSON (6 YEARS RECORD)

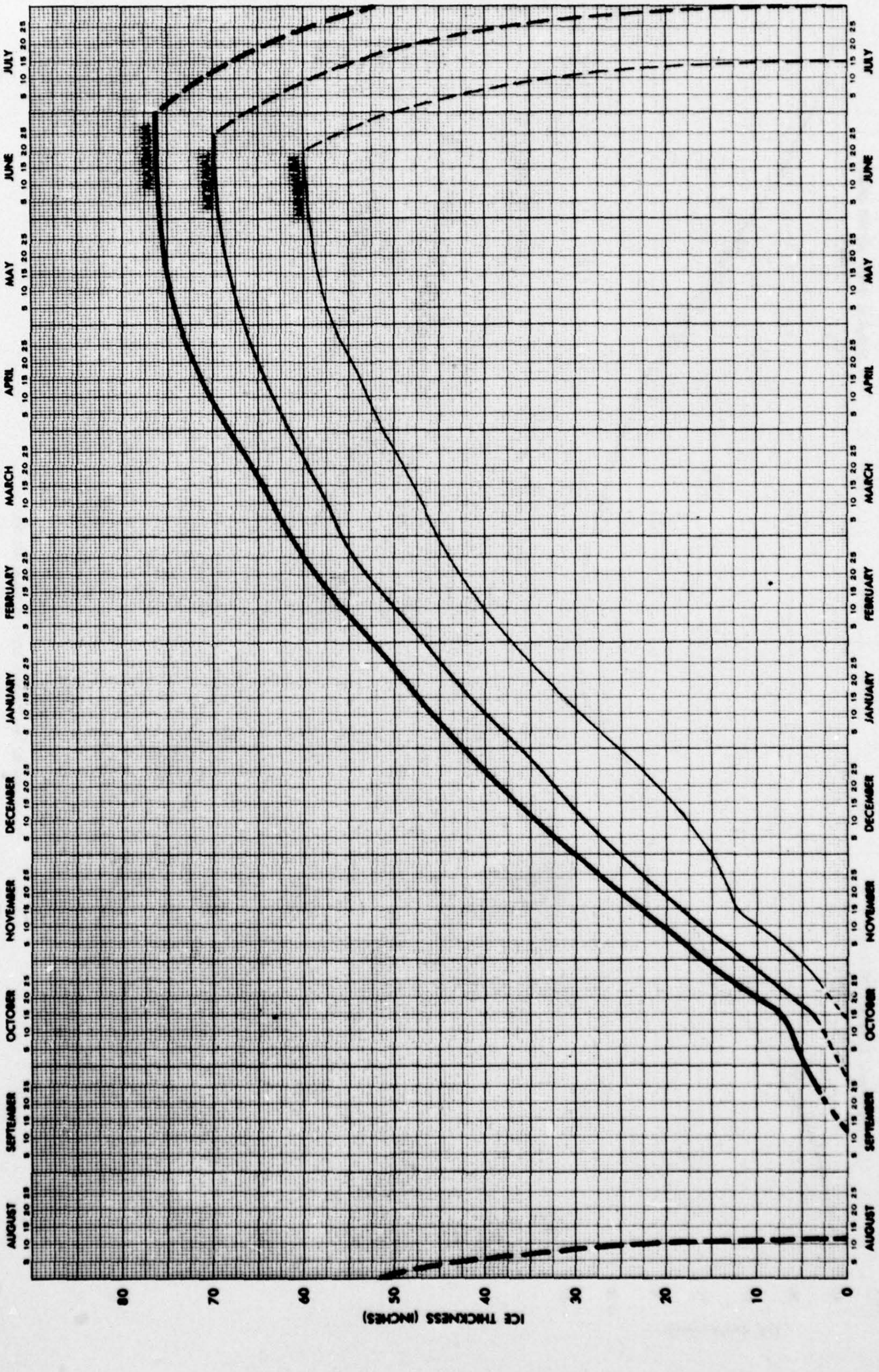


FIGURE 13B OSTROV DIKSON THEORETICAL ICE GROWTH AND ESTIMATED DISINTEGRATION CURVES

N..VOCEANO TN 7700-8-72

FIGURE 14A OSTROV BELYY (6 YEARS RECORD)

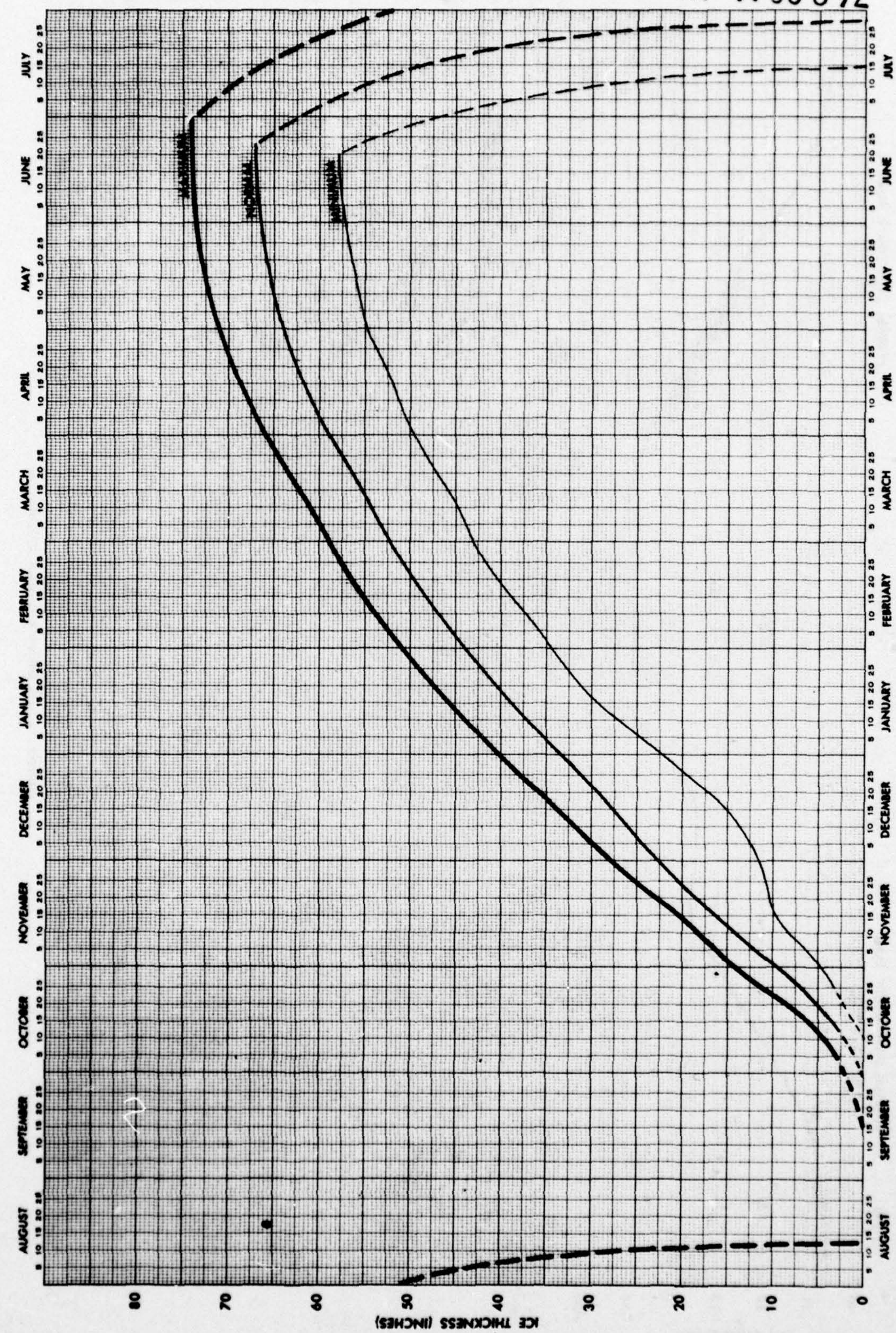


FIGURE 148 OSTROV BELYY THEORETICAL ICE GROWTH AND ESTIMATED DISINTEGRATION CURVES

FIGURE 15A MYS ZHELANIYA (6 YEARS RECORD)

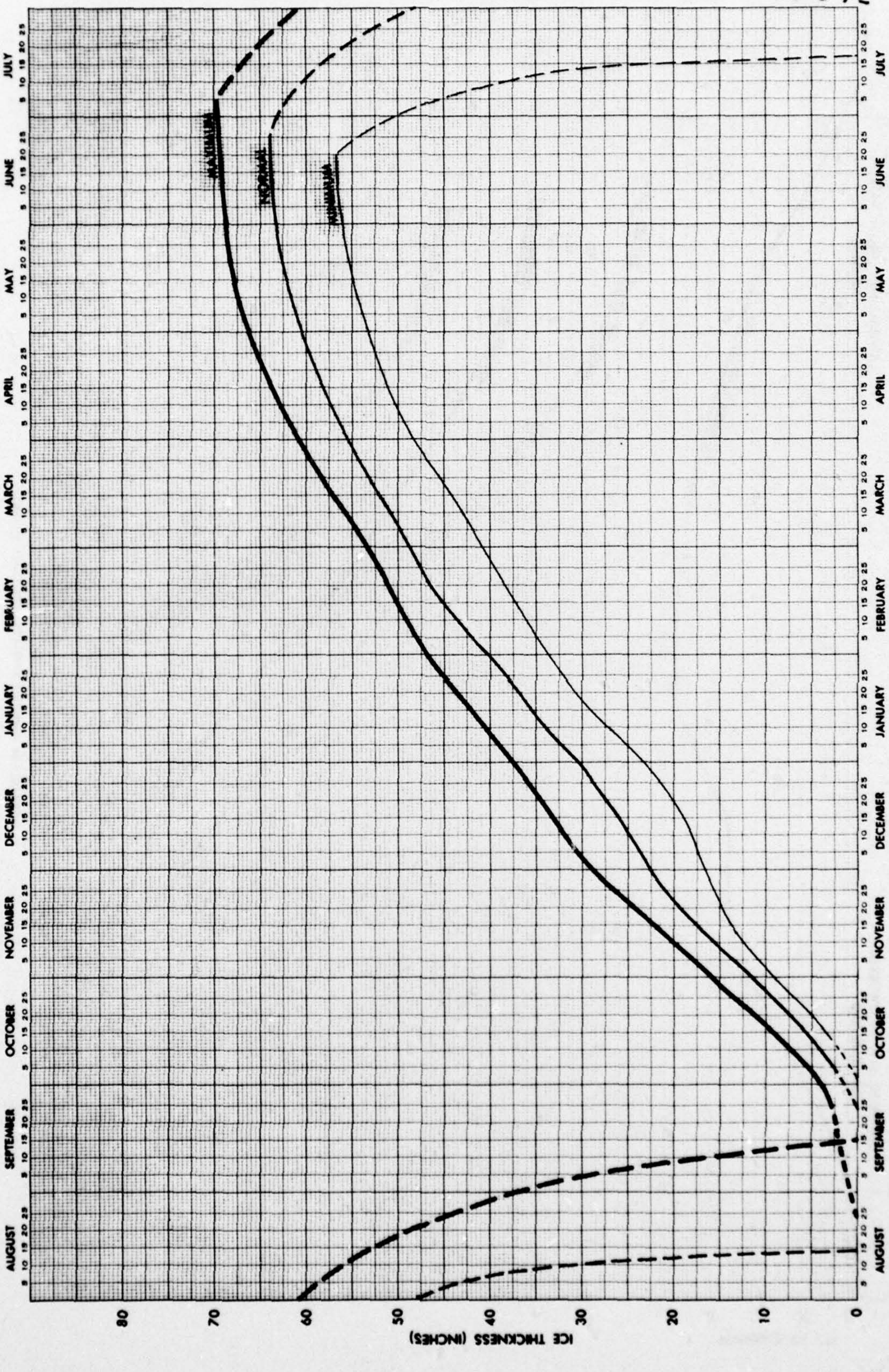


FIGURE 15B MYS ZHELANIYA THEORETICAL ICE GROWTH AND ESTIMATED DISINTEGRATION CURVES

NAVOCEANO TN 7700-8-72

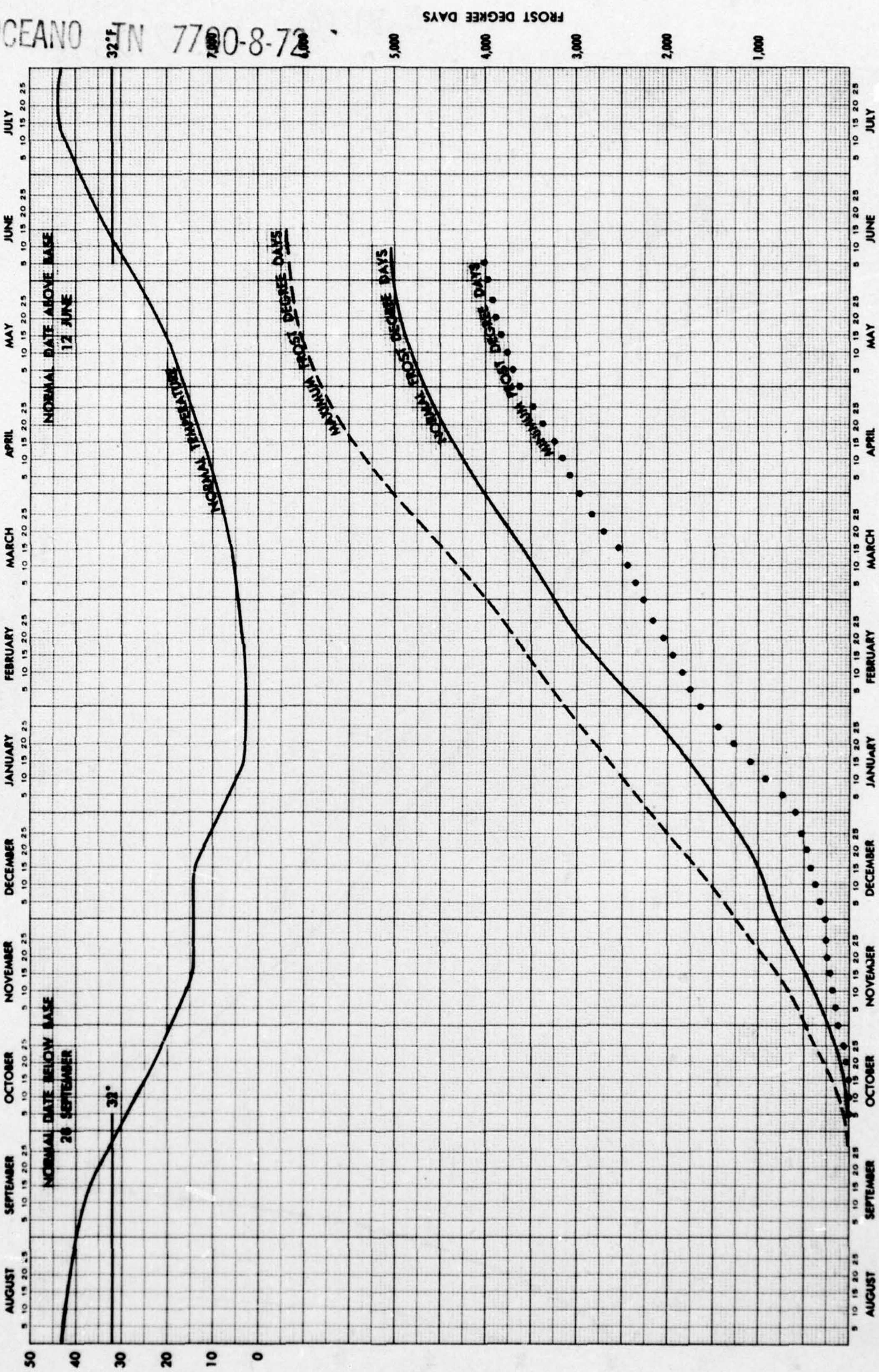


FIGURE 16A MALYYE KARMAKULY (6 YEARS RECORD)

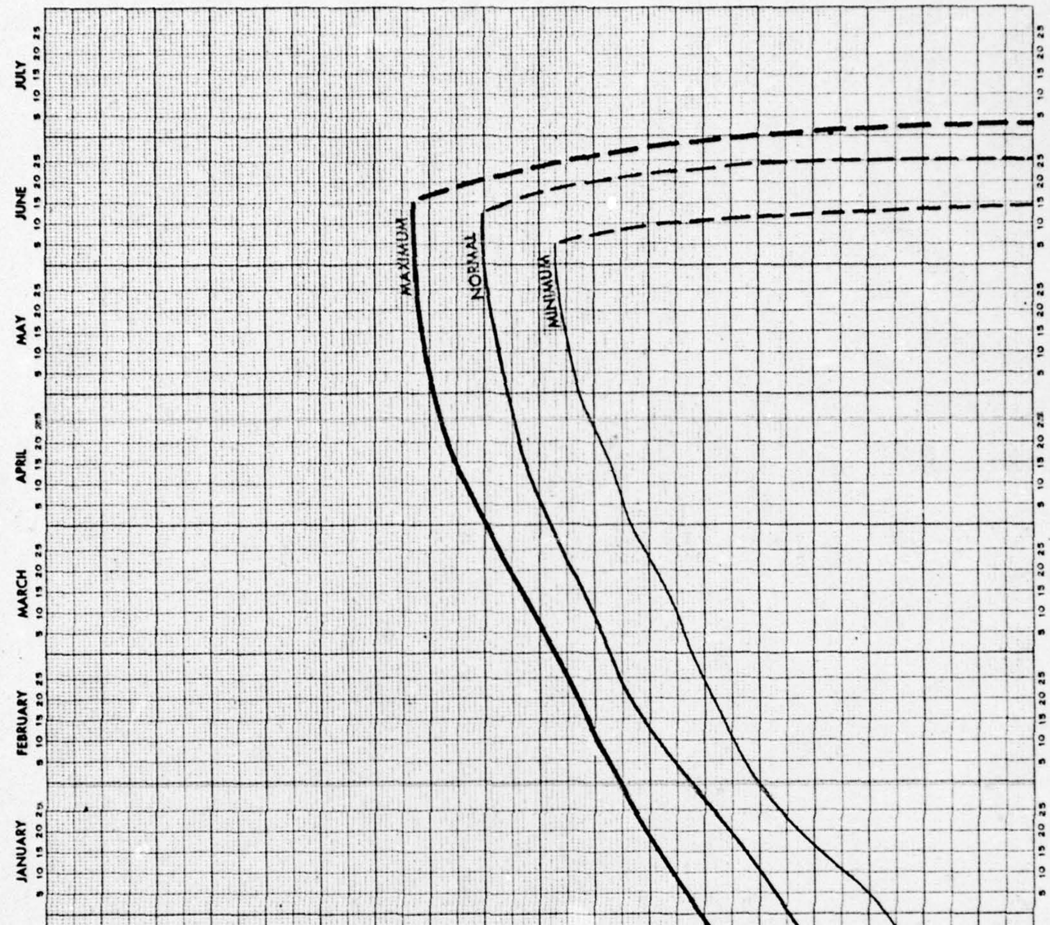


FIGURE 16B MALYYE KARMAKULY THEORETICAL ICE GROWTH AND ESTIMATED DISINTEGRATION CURVES

DISTRIBUTION LIST

DATE: 26 October 1972

SERIAL: 7700-8-72

SUBJECT: Frost Degree Day and Related Theoretical Ice Thickness Curves for Selected Russian Arctic Stations

TECHNICAL NOTE 7700-8-72	EVALUATION REPORT
PROGRESS/STATUS REPORT	OTHER
SYSTEMS ANALYSIS REPORT	
LETTER	

CLASSIFICATION: Unclassified

NUMBER OF COPIES MADE: 25

COPY NO.	(Internal)	COPY NO.	
1	Code 00	21	
2	Code 01	22	
3	Code 03	23	
4	Code 06	24	
5	Code 06B	25	
6	Code 30		
7	Code 3315		
8	Code 36		
9	Code 70		
10	Code 75		
11	Code 76		
12	Code 7710		
13	Code 7720		
14	Code 90		
15	Code 91		
16	Code 92		
17	Code93		
18			
19			
20			

REMARKS: